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INTRODUCING THE CONTRIBUTORS

WALDEMAR KAEMPFFERT ("Science, War, and Democracy") is Science Editor of the *New York Times,* and is also well known for his books, *History of Inventions, History of Astronomy,* and *Science Today and Tomorrow.* The paper which SCIENCE EDUCATION publishes in this issue was presented before a summer session conference of science teachers at Columbia University.

S. M. NABRIT ("Human Ecology of Georgia") is professor of biology at Atlanta University. During its summer session this year he directed a workshop for science teachers at which a community approach was made to the problems of science teaching. Dr. Nabrit's activities in biological research have been primarily concerned with the regeneration of tail-fins of fishes. He has recently turned his attention to the problems of realizing the potentialities of science for better living, and consequently has become concerned with the education of teachers in science.

LOUISE CROWDER ("First- and Second-Graders Study Foods") teaches in north central Alabama, in the T.V.A. region. Her school, a small rural one, is attempting to serve the children who attend it, and Miss Crowder's article indicates that the attempt is attended with some success.

RICHARD H. LAMPKIN ("Do Teachers Consider Suggestions for Teaching?") is currently engaged in war industry, but hopes to return to teaching after the war. Mr. Lampkin has been a science teacher and curriculum worker in the Cincinnati Public Schools and has carried on research in science teaching at Teachers College, Columbia University. In this issue he reports on the reactions of teachers of physical science to a suggestive guide in the field of electricity. His report reveals a condition which invites analysis by persons interested in the in-service education of science teachers.

JOE YOUNG WEST ("Meeting a War-Time Emergency") teaches science at the Maryland State Teachers College at Towson, and is one of the authors of a series of junior high science textbooks, *Science Problems.* Dr. West's article should be of interest both to those engaged in teacher education and to those working in elementary school science.

A note on the Annual Science Talent Search ("Is Your State Discovering Its Science Talent?") is contributed by HAROLD A. EDGERTON, Director, Occupational Opportunities Service, Ohio State University; STEUART HENDERSON BRITT, who is on leave from his professorship at George Washington University for service with the Navy Department; and HELEN M. DAVIS, a member of the staff of Science Service, Washington, D. C. All are authors of experience. Dr. Edgerton's publications on statistical and vocational procedures are widely used; Dr. Britt's book, *Social Psychology of Modern Life,* has recently gone into a fifth printing; Mrs. Davis' compilations of classics of science in various fields have appeared in *Science News Letter.*

A feature of this issue of SCIENCE EDUCATION is the symposium arranged by PALMER O. JOHNSON ("How Can Science Education Make Its Greatest Contribution in the Post-War Period?"). Dr. Johnson asked some sixty persons interested in science for their opinions about its role in post-war education. He found their replies both "interesting and useful"; certainly they are varied. Some of the statements appear this month; others will be printed in a later number.

SCIENCE EDUCATION

VOLUME 28 OCTOBER, 1944 NUMBER 4

SCIENCE, WAR, AND DEMOCRACY

WALDEMAR KAEMPFFERT
The New York Times

IT is no accident that we dance to swing music and not to minuets; for the dance is part of our culture. It is no accident that we ride in automobiles, listen to broadcast entertainment, work in fifty-story skyscrapers, turn our wheels by electric energy; for these, too, are manifestations of our culture.

GROUP BEHAVIOR

What is culture? For the present purpose it includes both social and private customs, art, religion, science, government, family relations, work, play, ways of waging war and earning a living, subways, airplanes, schools, a complex of laboratories and powerhouses, push button conveniences and motion pictures, public parks and football fields, hospitals and divorces, obligations to our families and the state. *We conjure up a picture of group behavior*—of a people influenced by common passions, motives, and interests. A social tension is manifest, a tension that compels us to act and think more or less alike.

In the Middle Ages this social tension expressed itself so strongly in religion that there were 110 holy days in the Christian year, that a new architecture evolved, that the whole of Europe engaged in crusades against the "infidels" of the Near East. If today we rush across the continent between sunrise and sunset in an airplane, talk across the Atlantic Ocean, read five-cent newspapers, determine the physical and chemical constitution of a star by light that left it when dinosaurs roamed the earth, it is not because the human mind is any better than it was ten thousand years ago but because we have acquired different interests and much knowledge under social tension. To a socially tense society relief comes through art, philosophy, arms, scientific research, commerce, depending on the needs that must be satisfied.

We express all this in the phrase, "the time is ripe." We mean simply that social tension has found relief in some law that has been passed, some important invention that has made its appearance, some great book that has been written, some extraordinary bridge that has been built.

THE GREAT MAN THEORY OF PROGRESS

It follows that great men do not create cultures but that cultures present great men with opportunities. Dante, Shakespeare, Beethoven, Edison, and Marconi respond to social tension and thus enable their fellow men to realize their dreams and aspirations. Great men appear in a community that is restless, progressive, dynamic, but rarely in a community that is stagnant, self-satisfied, inert.

If there is any doubt about this point, consider the Arabs. In the days when Islam was at its height they overran Europe, founded great universities in Spain, produced great poets, philosophers, mathematicians and scientists. After the unrest of Islam declined we hear of no important Arabian enterprise or great men.

Professor Alfred North Whitehead maintains that social restlessness is good and that the great ages of the past have always been unstable. To him it is the business of the future to engage in dangerous experimentation. One merit of science is that it equips the future for the task of being adventurous.

SIMULTANEOUS INVENTION AND DISCOVERY

That great cultures stimulate great men is also proved by the phenomenon of simultaneous discovery and invention. Professor William F. Ogburn and Dorothy Thomas have compiled a list of 148 major scientific discoveries made by different men simultaneously and independently [1]. Thus Newton and Leibniz devised differential calculus independently; Wallace and Darwin simultaneously hit on natural selection to explain the origin of species; Elisha Gray and Alexander Graham Bell filed patent applications for the telephone on the same day; and both were ignorant of similar work that Reis, a German, was doing.

This applies to art as well as to science and technology. Critics find it difficult to attribute unsigned masterpieces to the artist who is most likely to have produced them. The authorship of some of Shakespeare's plays is still in dispute. There is a striking resemblance between some of the philosophies and religious systems of the East and the West.

Professor Ogburn has also shown that exceptional men are distributed in a population much as are dwarfs and giants. Given statistics enough, it is possible to state the probable number of exceptional men in any community.

THIS SCIENTIFIC AND TECHNOLOGICAL CULTURE

We accept science and technology as the outstanding characteristics of our culture. By this we mean that our attitude toward our environment, toward the universe, is not what it was in ancient times. We have become investigators, testers, measurers. We have evolved a technique to examine everything from a star to a rock, from sea water to an economic depression. This technique we call "the scientific method," by which we mean a dispassionate, objective procedure which excludes from our examination, so far as that is possible, what we *want* to believe and what we like and dislike.

This approach is only a few centuries old. It is an approach that is difficult under a tyranny or under any system of government that does not permit considerable freedom of thought and action. If a government or a church—and often the two are one—dictates what must be accepted as the origin of the universe and of living creatures, we cannot expect a Newton or a Darwin to influence thinking. There always was some science and some technology in the world, but exact science and technology could not rise without liberalism. It is no accident, therefore, that science and democracy have progressed hand in hand and that the scientific attitude began to be cultivated in the Renaissance, when men were beginning to question the authority of the Church. After the French Revolution, which firmly established democracy, scientific research gathered momentum, until today it proceeds at so breathless a pace that even specialists find it difficult to keep abreast of the progress made in their own fields.

We are apt to think that science stands for synthetic chemistry, electric lamps, X rays, radioactivity, genetics. To be sure it stands for all these and more. It is the scientific method that is important, the attitude of mind that is the essence of that method—what Professor Whitehead calls

the most intimate change in outlook that the human race has yet encountered. This attitude, this objectivity, is inconceivable without the freedom of expression and action that we link with democracy.

Democracy as we know it is democracy of the middle class, a democracy of city traders. Traders always worked; noblemen did not. Experimentation is impossible without manual work, and manual work was always despised by the aristocracy. The trader needed the scientist—needed science because he needed exact weights and measures, needed exact methods of navigation, needed exact knowledge about the commodities in which he dealt, needed better means of transportation and communication. The scientist and inventor were not hired by the trader to solve problems, but the trader did create the conditions under which science and technology can flourish.

All this has been admirably elucidated by B. Hessen in a paper which appears in *Science at the Cross Roads* [2]. There it is made plain how much Newton owed to the commercial demand for more scientific means of navigation. Newton was not aware of any social pressure that was put upon him. But the pressure was there. After the discovery of America the old dead reckoning method of navigation could no longer meet the needs of ship masters. A situation was created to which Newton and others responded. Science typically progresses in this fashion. Sometimes it takes orders, as it does in industrial laboratories, but usually it responds to a situation that calls for action.

SCIENCE AND WAR

Trade and war have always been inseparable. It is no wonder, then, that scientists received their greatest inspiration from war. Those of the fifteenth and sixteenth centuries were more aware of this relationship than their successors of today.

With the introduction of iron cannon about 1410 research in ballistics received a powerful impetus. No one asked Galileo, Newton, Tartaglia, and others to study projectiles in flight, but they did, with the result that not only were artillery officers enriched with better ways of laying guns, but physics and mechanics began to develop.

Professor Robert K. Merton has dwelt on this unwitting aid that most pacific scientists have lent to the business of wholesale slaughter [3]. Concern with the expansion of gases, combustibility of powder, and the strength of metals aroused interest in what Merton calls "derivative problems," which seemed to be of purely academic interest. Experimenters, knowing nothing of the original impetus, imagined that they were pursuing research solely for its own sake.

The more primitive the form of industry and warfare the more obvious is the connection between science and daily life. Leibniz, Denis Papin, Otto von Guericke and scores of other seventeenth century scientific and philosophic celebrities all dabbled in what they frankly called "military mechanics." Galileo was actually a professor of military science. In the eighteenth century science was systematically taught only in the French artillery schools.

The relation of science to war persists to our own day, though it is more obvious when battles are raging than when peace reigns. To forearm herself against an inevitable British blockade Germany encouraged Fritz Haber to develop his synthetic ammonia process and thus was able to obtain the nitrates that she needed for explosives and fertilizers; Bergius, Fischer and Tropsch to conduct researches that ended in processes for converting coal into gasoline; Hoffman, Harries and others to devise synthetic rubber processes. It is impractical here even to list the discoveries and inventions that have come out of war.

This relationship of science to war becomes all the more striking when we compare the culture of China with that of

Europe. The Chinese invented gunpowder and cannon long before they were introduced in Europe. The Chinese are essentially a pacific people—so very pacific that the soldier was long regarded as a ruffian and placed on a low rung of the social ladder, with the barber. In the West the soldier was glorified, and every medieval nobleman was primarily a warrior. So it happened that in China nothing was done to apply experimental science to the improvement of warfare, whereas in the belligerent West everything was done to this end.

INFLUENCE OF WAR ON INDUSTRY

This influence of war goes deep and far. It penetrates industry. Mass production, for example, owes much to military necessity. Without interchangeability of parts mass production is impossible. And interchangeability began with the production of pulley-blocks for the English Navy in the middle of the eighteenth century and with Eli Whitney's method of making and assembling muskets. Whitney is the technological ancestor of the industrialists who produce automobiles, bathtubs, electric lamps, vacuum cleaners, bottles and containers in trainload lots.

Industry learned everything from war except invention—learned organization, discipline, standardization, the separation of line and staff, the division of labor (cavalry, infantry, artillery). Such is the power of military example that workers dress more or less alike, that "soda jerkers," hospital physicians, nurses, trainmen, elevator boys, theater ushers, policemen, and street sweepers are uniformed; that the doormen of hotels and motion-picture theaters resemble admirals and generals in full dress. Even the changing of the guard has its counterpart in a factory's eight-hour shifts.

TRADE AND DEMOCRACY

I have said that our democracy is a middle class democracy, a democracy of traders. That trade and democracy go hand in hand is natural. Traders of one country may not like those of another, but they ask no questions about rank, race, religion, or politics. Only one question is asked: Have you the money to pay for my goods or is your credit good? At the trader's counter, at a bankteller's window, lord and commoner stand on an equal footing.

Science has always been equally democratic. From time immemorial physicians, chemists, and physicists corresponded with one another and exchanged ideas. In normal times scientists meet in international congresses and ask no questions about race, religion, or nationality. This democratic spirit has been fostered by traders in the past. Today it is breaking down because the trader has become a monopolist, the middle class is disappearing, and science is now systematically pursued in the industrial laboratory and its discoveries and inventions are monopolized by patents so far as that is possible.

PATENTS, SCIENCE AND MONOPOLIES

Patents are limited monopolies. They have always been viewed with suspicion. Originally they were granted not only to inventors but to business men who introduced new industries. In Queen Elizabeth's time patents were granted to court favorites who monopolized the manufacture of playing cards, the importation of spices and many commodities, and the sale of soap and other necessities. The abuses became so intolerable that Elizabeth had to yield to the clamor for reform.

With the American revolution came a change—a typical democratic change. We saw to it that patents were granted only to inventors. The purpose was to encourage invention. What has happened since is something of which Washington, Jefferson, and Madison never dreamed. Patents are now the bases of great monopolies. Research is conducted to obtain new patents. Vast pools of patents make it almost impossible for the old-fashioned in-

ventor of the Goodyear and Morse type to start a business of his own. International cartels are based on patents. World markets are carved up, prices are fixed, production is controlled. What began as a laudable democratic policy intended to encourage invention and promote industry has developed into a method of entrenching undemocratic monopolies.

The point I am trying to make is this: The small city trader who fought for democracy in the American and French revolutions is no longer the power that he was. His place has been taken by the plutocrat who exploits science and invention through patents to achieve an undemocratic purpose.

Trusts, Cartels and Patents in Germany and the Democracies

The difference between the German and the American attitude toward the trust and the cartel is worth noting. In Germany monopolies have been encouraged and subjected to some state supervision and control; in the United States trusts and patent monopolies are viewed with suspicion and efforts are made to curb them through anti-trust laws, though not with conspicuous success. The reason for this difference in attitude is found in different political traditions, and in the cultivation of militarism in Germany and of isolation, if not pacifism, in this country.

Industrial Research

In the old days the inventor worked alone. Sometimes he was financially aided by some capitalist who believed in him and saw profits in his ideas. It was the Germans who changed this conception of the inventor's place in industry. They showed that research can be planned and organized to speed manufacturing progress and create new demands.

Mauve, the first coal tar dye, was the discovery of Perkin, an English chemist (1856). But the coal tar industry was largely German up to 1914. Almost from the first there was organized research in Germany—the systematic examination of coal tar and hence the systematic development of organic chemistry. By 1900 there were literally hundreds of coal tar drugs, dyes, flavors, explosives, photographic developers. German chemical firms were merged into a trust which centralized research. Obviously a similar system could do much for lamps, telephones, shoemaking machinery, fertilizers, automobiles, metallurgy. So it has proved. Invention is no longer a haphazard undertaking. It is a profession. Research is now as essential in industry as manufacturing and selling.

Compelled to compete with organized industrial research, the outside "heroic" inventor is no longer the factor that he was. Edison may have been the last of the type. If the heroic inventor survives at all he is almost certain to be a university physicist or chemist or a trained engineer, rather than an empiricist such as Goodyear, who patiently and inspirationally performed several thousand experiments before at last he achieved the vulcanization of rubber. The heroic independent inventor finds it almost impossible to compete with a group of hired chemists, physicists and engineers who have at their disposal splendidly equipped libraries, experimental apparatus, money, patent lawyers to guide them, and time.

Planning, organization, and competent direction telescope decades into years and effect enormous economies, exactly as in manufacturing. Laissez-faire is as obsolescent in industrial research as it is in economics.

It is worth noting that in this country research received its great impetus soon after the Sherman law was passed. The courts interpreted the rights of a patentee so liberally that it became possible to monopolize an industry in ways that were impossible under the Sherman law. Now the courts are trying to reverse the earlier decisions and to curb patent monopolies.

INTRODUCING ENERGY

Science is concerned with the study of materials and energy. The two cannot be separated. Increase the amount of energy that can be concentrated and the need of new materials becomes manifest. Provide the new materials and new inventions follow. We have learned to look upon coal and petroleum not as fuels but as sources of energy. Enraptured though we may be by the spectacle of a magnificent waterfall we cannot help imagining how much power it could furnish. This attitude is comparatively new. It is not more than a century and a half old. It would never have occurred to Caesar or Napoleon that coal or petroleum are worth fighting for because they are sources of energy.

THE COLLECTIVISM OF ELECTRIC POWER

Compared with the electric motor the steam-engine is a more democratic machine. By this I mean that the steam engine must be used individualistically. Electric energy, on the other hand, is used collectivistically, which means that millions of consumers are supplied with energy by a single central station. Not only this, but regional power pools can be created which can be tapped wherever land is cheap, transportation is good, and labor is reasonably abundant. After the steam engine came, workers flocked to it; after dynamos and motors were introduced, energy could be flashed to the worker, wherever he might be.

The distance to which power can be transmitted by a steam engine is limited to a few feet by a belt or a rope. For this reason the steam engine had to be used individualistically in a factory. That is, the factory owner had to install his own boiler plant and engines.

When Edison built the first central station in 1881 this picture commenced to change. Electric energy is now flashed hither and thither over a region 250 miles in radius. Central stations are interconnected so that a few of colossal size can take the place of many.

We have, then, a definite trend to the collectivistic use of energy generated in a few centers. If the introduction of the steam engine is one of the factors that brought about the Industrial Revolution, then the advent of electric energy marks another revolution. I do not mean merely that farms are now electrified, that central stations now milk cows, suck dirt out of carpets by way of vacuum cleaners, drive factory machinery, light whole cities. The effect is deeper and wider. Electric energy is now like water and gas to communities—something indispensable. The central station is more than the purveyor of energy. It knits factories, household, and subway systems into a single social fabric.

PRIME MOVERS AND INVENTION

A prime mover, such as a steam engine or an electric motor, must move something. Given the prime mover and there is a clear call for inventions that can be driven—for machines that will do the work of muscles.

Soon after the steam engine was introduced not only were labor-saving machines invented, but also machines to build other machines. A process of reproduction was inaugurated that seems appalling to some and romantically captivating to others. Industrial nations are now machine-driven nations.

The countless machines that do the work of hauling, lifting, pressing, punching, boring, folding, twisting, cutting, and bending are all highly specialized, artificial organisms. Industrial processes are carried out by tireless automata which are nothing but extensions of human muscles and senses controlled by human brains. Not only is labor more minutely subdivided than ever before, but skill and something that resembles intelligence has been transferred to the machine.

MASS PRODUCTION AND STANDARDIZATION

Machines are elements of the system of mass production. Mass production is im-

possible without standardization. We cannot have cheap automobiles, cheap bathtubs, cheap lamps, cheap furniture, cheap canned foods unless they are standardized. Even our entertainment is mass-produced and standardized in the form of motion pictures and radio.

There is no question that mass production and standardization have relieved the world of much drudgery and given it more time for recreation and education. But we have had to change our concept of freedom. We are regimented by the machine. Mass carriers in the form of railways and steamships, motion pictures and radio entertainment for the masses and not for special tastes, canned foods for all, electric lamps that are all alike, vacuum cleaners and washing machines that are indistinguishable from one another, furniture in one house much like that in any other, clothing that is anything but distinctive, newspapers that print much the same news—all this is a boon because it is a convenience, but it is also curtailment of freedom. We are not as free as were our ancestors of colonial days, though we have luxuries of which they never dreamed, and there will be less freedom.

On its face all this seems like a trend toward democracy. It is not. The public has nothing to say about the methods of production and marketing, and the workers very little. Two centuries ago a farm was a little self-contained world of its own. Everything was made on the farm. Fibers were spun and woven; meat was smoked and food preserved. Today the farmer is as dependent on the factory as any of us—dependent not only for clothes but even for much canned food.

THE RULE OF THE EXPERT

Mass production on the modern scale implies control—organization. In a factory the worker knows only the name of the part he places in a machine. He is simply Operator 25, or his job is to turn out daily two or three thousand identical bolts for a contrivance that becomes an automobile or a tractor. *A few engineers at the top alone see the mill and its products as a whole.*

I do not know how many experts actually control our machines and processes of production. We find them everywhere—in the banks, in powerhouses, in skyscrapers, in huge hotels. To them we must add the scientists who make new discoveries in industrial laboratories and the engineers who design new machines and devise new processes.

These expert financiers, researchers, and designing engineers are the molders of our social destiny. It is they who actually design this society. If some deadly disease were to afflict them simultaneously we would die of starvation or of some pestilence.

Professor James Burnham has developed this theme in a book which he calls *The Managerial Revolution* [4]. As he sees it we have in the scientists and engineers who design and operate the machinery of production a new aristocratic class which has usurped the functions of government in Russia and Germany. If Stalin and Hitler had ever been executives in a factory or designed new productive machinery this conception would be easier to accept than it is. *Actually the industrial scientists and engineers who are shaping a new world are part of the capitalistic system.* They are the hirelings of financiers.

The cry for economic reform does not come from these experts at the top. They are well paid. They are not revolutionists. They are not banded into unions created to wrest control of the economic system from the financiers. What we behold in their rise is something much more important.

These expert technologists who design the new machines and see to it that the complex mechanism of powerhouses, railways, and factories functions perfectly are trained organizers and planners—they and

their employers. Democracy dislikes organization and planning because they are impossible without control and without some dictation. We know that the old laissez-faire system cannot meet modern economic needs. *There must be planning and hence control. Who is to plan and control?* Shall it be the technological experts and the financiers behind them? Or the government?

Almost from the first governments realized the necessity of owning or controlling such activities as the carrying of mail, the supplying of communities with water, gas and electricity, telegraphing and telephoning. *Now there are signs that the production and distribution of goods and the regulation of prices must also become functions of government.* In a word, the mechanism of mass production so vitally affects the masses that they are possessed by a vague fear of slipping back into something worse than serfdom if the experts in finance and technology are not controlled. *They want to preserve democracy and the freedom that it guarantees.*

Science, technology, and mass production mean technical competence, a high degree of competence. It is clear that a democratic government must be as technically competent as are the experts if it is to survive. This is the issue of fascism and communism on the one hand and democratic, parliamentary forms of government on the other.

Democracy as we know it is a heritage of eighteenth century liberalism. It comes down from a time when there were no railways, no huge factories, no powerhouses. Men wrote with quill pens and not with typewriters. Most of the world's work was done by the muscular energy of men, horses and oxen. *This democracy of ours is a political conception.* It is based on government by representation. Any citizen in a democracy is more or less competent to talk politics and to vote, but he is not competent to talk about electrons, kilowatt-hours, synthetic chemistry, or international banking.

It has been said over and over again that technologic invention has outstripped social invention and that we have failed to make social adjustments compatible with technological innovation. The statement is not strictly true. Fascism and communism are social inventions designed to cope with the very problem presented by science and technology—the problem of a society which must be administered either by the technologists and their financial backers or by a government which is as technically fitted to perform its task as are the technologists and financiers the one to which they have addressed themselves. *The champions of fascism and communism have decided that a democratic, parliamentary government is unable to cope with the problem.* It is unwieldy because of the number of representatives who discuss and vote on questions about which they know virtually nothing, and it is hence incompetent. It is a democracy of traders, as everyone knows, a democracy which has evolved into a plutocracy with the outward form of a representative government.

If it is to survive, democracy must adapt itself to the machine. The generation and distribution of the electric energy now indispensable in production, the mass production of standardized goods, mass carriers, mass entertainment, and mass education—all these are forcing us into grooves, forcing collectivism upon us. We must reckon with collectivism in some form. This does not mean that we must become communists. The essence of democracy is to be found in political equality, freedom of thought and expression, and the preservation of civil liberties guaranteed by the Bill of Rights. *None of these is to be found in a fascistic or communistic state.*

If we are to preserve this essence of democracy the government must become as technically competent as those who now control the machinery of production. That

we are not utterly helpless is demonstrated, I think, by the experiments that we have made in the past.

We have created, for example, a Federal Interstate Commerce Commission to regulate railways, a Federal Communications Commission, a Federal Trade Commission, and similar bodies. In some states there are Public Service Commissions that curb the rapacity of public utility companies. In Great Britain Parliament has resorted to the Royal Commission system when it needs expert advice. But to me the most striking evidence of democracy's willingness to experiment socially is presented by the Tennessee Valley Authority. Here we behold the government guiding the destiny of a rich and fertile region in a fashion which is new and which is successful. Not only is electric energy generated on a vast scale by waterpower, but the utilization of that energy is integrated with farming, manufacturing, transportation—with every activity of the Valley. The TVA sells nothing directly to consumers, not even electric power. The public utility companies which buy the power wholesale and then retail it no longer oppose what they once called the entry of government in business.

We have in the TVA an example of what a democratic Congress can do by way of social invention. But we need more. *Congress itself needs technical assistance.* Its committees now listen to testimony which is often tedious and irrelevant on matters of national importance. It could save time if it resorted to the Royal Commission system of Great Britain; that is, if it asked experts to report on questions that only authorities can illumine. The reports of a Royal Commission are not binding on Parliament, but they are usually followed in principle.

This system is not unknown in the United States. We, too, have advisory boards. But they are appointed by the President and they report to him. Congress pays hardly any attention to the reports, though many of them embody the opinions of experts who have studied the problems assigned to them for months and years. Probably the English system is better. That is, Congress would act with more social daring if it appointed the advisory boards itself and received the report.

We cannot experiment with social inventions as we experiment with machines. The *mores* forbid man to experiment on man. We may sigh for an island with 100,000 inhabitants, a place where we can conduct experiments in community life, but by the very act of isolation we make it impossible to judge world effects.

In the last analysis we must depend on education to solve the problem of democracy and its survival in the face of the regimentation brought about by science and the machine. We are not yet a highly educated people. We elect men not because they are good business men, good engineers, good doctors, or good economists, but because we like them, because they make vague promises that appeal to us, because they are popular in their communities. Congress is composed largely of country lawyers. If this were still the eighteenth century, if the questions that concern us were merely political questions, there would be no reason for a different system. But when we think of country lawyers elected emotionally because of their vague promises it is plain that we need something better. We need men in public office who are at least as intelligent as university professors, men who have received a first-class education in sociology, economics, history, and above all in science and technology and the influence they have on life. So we come back to government by politicians who know only politics and government by men who are as expert as are financiers and technologists in their own fields. Democracy can survive, even though it must pay more attention to economic equality, if it is willing to be-

come either expert itself or learn how to make use of experts. The alternative is either fascism or communism.

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HUMAN ECOLOGY OF GEORGIA

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THE interplay of forces making for adjustment or maladjustment in human living can be best understood by discovering various problems and attempting a scientific analysis of them. Knowledge of forces of nature, and knowledge of balance and interdependence between the living and nonliving components of the environment, can be gained from the study of human ecology, together with control and improvement of these interrelationships.

Any course in human ecology should have as its objectives to (1) examine the physical basis of the universe, with a special consideration of the environment of a particular community; (2) analyze the ability of the environment to support the community; (3) discover the nature of waterflow and its effect upon the sustaining capacity of the environment; (4) make and record observations about the climate and man; and (5) formulate a plan of attack upon problems arising from unfavorable relationships among men and from the mutual impact between man and the environment.

One way in which students, who have been unaccustomed to crossing rigid departmental barriers in relating science experiences or to using science skills in solving problems in human living, can be stimulated and taught to integrate many learning experiences in consideration of a problem, is through a study of human ecology. In Atlanta University we propose to use city and state ecological problems in helping preservice secondary school teachers develop techniques for community study, methods of working toward solution of their problems, and an organization of generalizations concerning human living. In brief compass there follow the suggested areas of consideration on human ecology in Georgia.

PHYSIOGRAPHY AND GEOLOGY

Physiographically considered, Georgia is divided into five well-marked subdivisions, namely, the Coastal Plain, the Piedmont Plateau, the Appalachian Mountains, the Appalachian Valley, and the Cumberland Plateau. (See Fig. 1.)

The crystalline rocks, such as Stone Mountain near Atlanta, are among the oldest rocks of the state. They are said to be of Pre-Cambrian age. Stone Mountain is a granite rock which formed from molten lava that moved up from the interior of the earth and hardened before it reached the surface. It cooled slowly below the surface of the earth and formed coarse-grained materials such as feldspar, quartz, and mica. Gneisses and schists are rocks that were mashed below the earth's surface, subjected to high temperature, and recrystallized, producing banding.

At the close of the Paleozoic era or the end of Carboniferous times, the crust of the

earth was mashed by great forces coming from the east. The sedimentary beds of the Appalachian Valley and Ridge section were folded into anticlines and synclines. Crustal change is associated with a pull of gravity toward the earth's center. The inner layers of rock are compacted and the surface layers are left loosely fitted about the inner ones. The readjustment of surface to center causes earthquakes and produces folds.

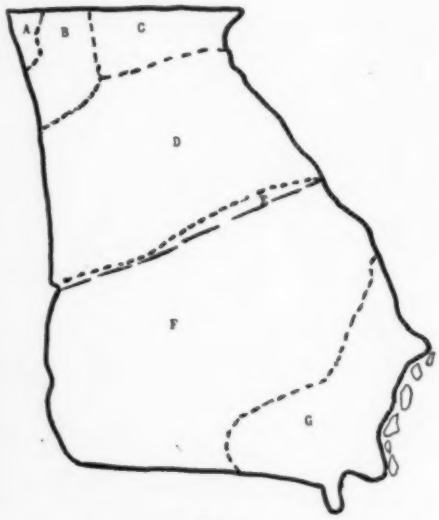

FIG. 1
PHYSIOGRAPHIC REGIONS OF GEORGIA
A. Cumberland Plateau
B. Appalachian Valley
C. Appalachian Mountain
D. Piedmont Plateau
E. Fall Line
F. Coastal Plain
G. Coastal Flatwood

Following the close of the great period of folding, the rocks were eroded by rains and westward-flowing streams for millions of years. By the beginning of Mesozoic times, eastward-flowing rivers were carrying vast quantities of sand and silt down to the Atlantic Ocean and depositing them near what we now call the Fall Line. This marked the origin of the Coastal Plain. Throughout the Mesozoic era, the tertiary times, and to the present, the Atlantic Ocean had gradually receded eastward. The shore has moved from a line passing through Augusta, Macon, and Columbus to its present position. As the sea receded, the Coastal Plain rose above sea level.

SOIL

The color, chemistry, and physical structure of Georgia soil profiles are due to early geologic formation, temperature, precipitation, leaching, erosion, and organic cover. Soils from granites and gneisses are high in potash and low in calcium. The soil from dark rocks are high in calcium and low in potash. At the average temperature of this area, oxidation is rapid, extending several inches in the subsoil. The various oxides of iron produce the red, yellow and black soil color.

Closely growing grasses produce more humus than forest cover. The grasses disintegrate above and below the surface; this insures better dissemination through the upper portion of the soil mass. The roots of trees penetrate the subsoil, form drainage channels for surface waters so that their leaves are the sole source of humus. In grassy regions the soil is dark. The red land is rich and is used for cotton; the poorer land is used for diversified farming. (See Fig. 2.)

FORESTS

Sixty-one per cent or 23,000,000 of the 37,583,900 acres in Georgia are classed as forest or potential forest land; one million of these are in virgin timber. The natural forest climax was hardwood with pine. The present cut-over pine forest is a result of man's cultural practices and lack of time necessary for a climax condition to reestablish itself. Pines having seeds scattered by winds invade abandoned cotton land faster than the hardwoods.

Georgia is second only to Florida in its variety of trees. There are 165 species of trees in Georgia, some indigenous to the north and others tropical in origin. Between these extremes are most of the trees

common to the eastern part of the United States. The short-leaf pine in the northern part of the state and the long-leaf pine of the Piedmont and Coastal Plain regions are adaptations to the rapid runoff of water in the mountainous regions, for in short-leaf varieties less water is given off by transpiration.

Along streams in moist places one can find willow, ash, water oak, river birch, cottonwood, yellow poplar, elm, and sycamore in almost every part of the state. In south Georgia are found in moist sites tupelo, gum, bay, cypress, pond pine, and magnolia. Optimum sites for yellow poplar are the moist coves of mountains. On drier sites, such as are provided by sloping lands, hills and mountains, one may look for pines, most of the oaks, hickories, persimmons, sassafras, dogwood, red cedar, ironwood, chestnut, mulberry, haw, and sourwood.

Georgia produces 57 per cent of the naval stores output of the country. Naval stores are rosin and turpentine obtained from gum produced by leaves in response to injury of the trunk of slash and long-leaf pines. The larger the crown of foliage, the greater the yield of gum. The trees are chipped about one-half inch each month except during January, February and March. The timber is marketable following the chipping and bleeding.

The annual value of forest products is about $60,000,000, and another $56,000,000 is added by manufacture. Because of the enormous forest acreage, the long growing season and abundant rainfall, paper mills are moving into the southeast.

CLIMATE AND CROPS

Climate is determined by the radiant energy of the sun, position in respect to polar region and equator, the wind currents from these two regions, topography and distance from the ocean. Precipitation in Georgia averages 48.3 inches annually. The mean annual temperature is 58⅔° F. The mean January temperature is 43° F., and the mean July temperature is 78° F.

The average of 233 frost-free days gives the South a climatic zone not found in Europe, and makes possible the growth of cotton. Cotton requires an average of 60° F., 180–200 frost-free days, 20–60 inches of rain annually, and open sunny weather or, at most, no more than half cloudy weather. The total cotton acreage in Georgia was 1,800,000 in 1940.

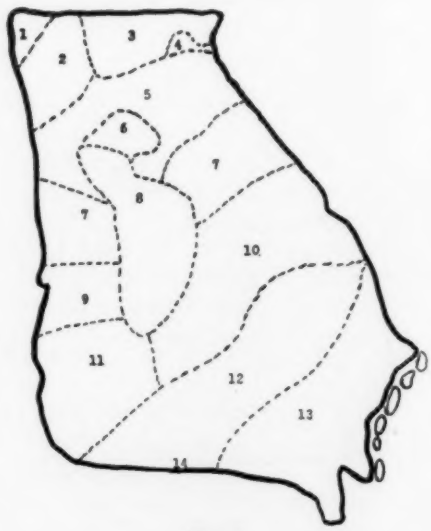

FIG. 2

REGIONALIZED TYPES OF FARMING IN GEORGIA

1. General farming
2. Tennessee limestone valley—general farming.
3. Self-sufficing southern Appalachian region
4. Miscellaneous berry and tree fruit areas
5. Northern Piedmont—cotton and corn
6. Mixed city farming
7. Southern Piedmont—cotton and corn
8. Peaches
9. Cotton and corn
10. Eastern coastal plain and sand hills
11. Gulf coastal plain—cotton, corn, peanuts
12. Tobacco and general farming, sugar beets
13. Atlantic and Gulf Coast flatwoods
14. Cigar types of tobacco

Corn, the most important cereal crop, is not limited so much as cotton in its distribution, but corn itself varies greatly in number of leaves, height of stalk, time of maturity and yield. There were 4,200,000

acres of corn in Georgia in 1940. By 1945 a hybrid corn will be in general use in the state.

POPULATION

The 1940 census of Georgia indicates that the state is divided into a white and Negro population in a ratio of two to one, and totaling 3,123,000. Negroes are concentrated in the cotton belt and in counties with a large urban population. (See Fig. 3.) Foreign-born whites and non-whites other than Negroes are negligible in number.

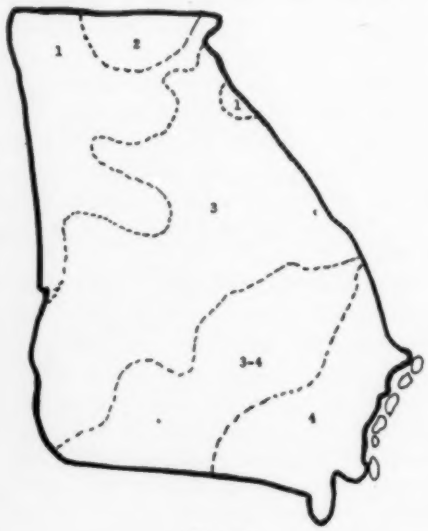

FIG. 3

RURAL CULTURAL REGIONS IN GEORGIA

1. Textiles.
2. Subsistence farming. Population is almost entirely white.
3. Southeastern plantation. Forty per cent of the population is Negro.
4. Lumber and furniture. One-third of the population is Negro.

Georgia led the nation in non-white net population loss in the prewar period of 1935–1940. The net loss was 30,801, and was almost entirely due to the migration of Negroes. There are usually inherent causes for migrations, such as low economic status, lack of opportunity, or the friction associated with a scarcity economy.

Negroes were brought to America and enslaved in the South as a source of cheap labor. They represented a capital investment that vanished after the Civil War. They were not only a source of contention between the North and the South, but served to divide the South into classes whose interests were antagonistic. The slaves made possible the plantation system, and forced marginal farmers into the hill country or toward the western frontiers.

The upland or hill people among the whites who carried on a subsistence economy differed greatly in physique, attitude, politics and health from plantation dwellers. The uplanders probably were considered shiftless because their diet of corn meal, fatback, and molasses was inadequate and produced pellagra and other dietary defects. The uplanders' lack of contact with the outside world and their lack of education left them a backward people. The desire for roads to market from the hills led to political feuds, because taxes would have had to be levied on plantations to build and maintain them. Observation of changes produced in people who came to Georgia as recently as 1733 through environmental effects should make it possible to see that stereotyping races according to abilities which are greatly influenced by the environment is without scientific justification.

Emphasis on group differences is an ancient and easy technique for use in exploitation of elements of a population. When race is used as the qualification for any desired status, one should examine the concept of the word "race." Under the aegis of superiority of race, the Negro is denied an equitable share of education, health, work, and participation in his government.

There is anatomical usefulness in knowing physical differences that are most frequently occurring in the different races.* But even these differences, if used in strict

* For a discussion of this point, see Washburn, S. "Thinking About Race." *Science Education*, 28: 65–76, March, 1944.

classification of other biologically similar groups, would set them apart as subspecies rather than as races. In evolutionary time man has existed much longer than modern races have existed. A given race is likely to include physical variations as great as any it excludes. Among the Caucasian peoples skin color varies from the white of the Nordics to the dark brown of the East Indians. The shape of the skull is highly variable, from broad and round to long and narrow. Hair varies widely in color and texture. Genetic differences occur between individuals but overlap between races. Less variation occurs between human beings than among any similar group of mammals.

EFFECTS OF CULTURAL PRACTICES UPON THE AREA

The tobacco, cotton, and corn type of colonial economy leached and eroded the soil and caused planters to abandon the coastal regions and move ever inland, leaving grass, shrubs and trees, the plants in succession, slowly to cover the exposed land. All these clean-tilled crops remove minerals from the soil and open the land to sheet and gully erosion. In some areas the land has been permanently ruined; in others, control measures could restore the productivity of the land. Seventeen per cent of the farm income is spent for fertilizer.

The change from the original condition, when the streams were clear and abundant with game fish, to the present time, when Georgia's streams run yellow with eroded soil and trout and bass have departed, is man's harvest from his bad cultural practices on the land.

Because of the practice of using the rich red land for cotton without diversification, a crash in the cotton market or a failure of the crop panics the red land farmer. In the early twenties, when it was wet enough to favor boll-weevil infestation in middle Georgia, the diversified farmers were not struck so severely as the red land farmers. Foreclosures, fall in land values, increase in sharecropping, and migration to cities were some of the results.

HEALTH AND SANITATION

There are at least thirty-six species and eight genera of mosquitoes in Georgia. Five species are vectors of diseases affecting humans. Six other species transmit diseases under experimental conditions. Some oviposit in tubs or cans; others prefer temporary pools, permanent pools or salt marshes. Some species of anopheles, aedes and culex are important in relationship to malaria, black-water fever, filariasis, dengue fever, equine encephalomyelitis, tularemia and lymphocytic choriomeningitis.

Infestation of domestic animals by mosquito-borne parasites and the loss of blood from frequent bites can alter the physiological balance in animals, and in cattle even lower milk production to a serious extent.

During 1939, a fall malarial survey was conducted in thirteen counties by county, regional and state-wide personnel. Of 17,479 blood examinations, 2.4 per cent were positive. Spleen examinations were made on 338 individuals, of whom 1.33 per cent were found to have enlarged spleens. The blood indices of Negroes for malaria were five times those of whites, the percentage in Negroes being 3.88 and in whites 0.68. Malarial incidence was 30 per cent higher among Negroes than whites per 100,000 population. The indices were lower in 1939 than they were in 1938. The trend is comparable to the death rates from malaria, 4.7 and 3.1 per 100,000 in 1937 and 1938, respectively. In fact, the trend in the state is toward a higher index in the southwest and a lower one in the southeast. (See Fig. 4.)

The total number of malarial deaths certified in Georgia in 1940 was 89, a rate per 100,000 population of 2.8. This is 38.4 per cent of the average death rate from malaria for the previous ten years. Reported malarial morbidity was low for the

state as a whole in 1940, totaling 2,503 cases. This is the apparent attack rate of 80.1 per 100,000 population, or 38 per cent of the previous ten-year average annual reported case rate. Obviously, there are errors in mortality and morbidity reports, but a trend can be observed.

Hydrology is important because the amount of rainfall, the season in which it falls and the drainage are all related to the cycle of the female *Anopheles quadrimaculatus* mosquito.

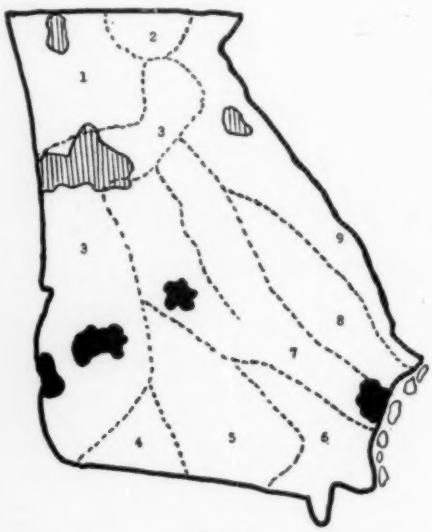

FIG. 4

DRAINAGE BASINS AND MALARIAL DEATHS

1. Tennessee
2. Coosa-Mobile
3. Appalachicola
4. Ochlockonee
5. Suwanee
6. Satilla
7. Altamaha
8. Ogeechee
9. Savannah

Vertical hatching—As many as 10 malarial deaths per 100,000 population.
Blackened areas—As many as 25-50 malarial deaths per 100,000 population.

The mosquito becomes infested upon taking spores from the blood of the malarial patient and, permitting the gametocytic phase of the plasmodium to occur. Through salivary injections into the next victim the disease is spread. Therefore, by chemical treatment of the patient's blood with plasmocine, atabrine or quinine, elimination of breeding places by destruction of cans and watermelon rinds, and by effective screening of patient and possible victims, the incidence to malaria could be decreased.

Public health officials of the State and Federal governments have been employing biology teachers as summer workers in malarial control. Although Negroes are more infested than whites, Negro teachers have not been included in this program. The nature of the disease is such that its eradication for one element of the population requires its elimination in all. The condition is not exactly comparable to that of the venereal diseases, in which case there was some indifference concerning eradication among Negroes prior to the war.

HOOKWORM

Hookworm infestation is influenced by the moisture, temperature, and physical nature of the soil, and is related to the cultural practices of the area. If the rainfall is less than forty inches annually and if it is not well distributed throughout the year, the infestation is greatly retarded. A six-month dry season is almost as effective as mass treatment of an area.

Necator americanus, Georgia's chief offender, is predominantly a tropical or subtropical species of hookworm. The optimum temperature for necator is from 86° to 95° F. Killing frosts for two or three nights will remove many larvae from polluted soil. It appears that eggs and young larvae are more susceptible to temperature than older larvae.

The physical nature of the soil is much more important as a natural selection factor for hookworms than the chemical nature of the soil. The finer the soil texture, the smaller the yield of hookworm larvae. In Crawford County in Georgia there is a sandy belt with a very high incidence of victims among the inhabitants of the belt, but on the adjoining land the incidence is very low. The larvae are positively thermotropic and migrate toward the surface in

the day and away from the surface at night. It has been suggested that considerable energy is used in such migrations and the finer the texture of the soil the greater the expended energy.

Poor waste disposal, and lack of septic tanks, stone privies or any privies at all, increase the spread of hookworm. The same is true of other diseases associated with poor environments, low incomes, and inadequate education concerning good health practices.

TUBERCULOSIS AND SYPHILIS

In 1940 there were 648 Negro males and 832 females reported for tuberculosis. At the same time, there were 662 white males and 559 females reported out of a population that is double the Negro population. There were 89.8 cases per 100,000 total population and 49.1 deaths resulting from tuberculosis per 100,000 in 1940. The fatality rate is 54.7 per cent.

The case rate for syphilis was 680.6 per 100,000 total population reported in 1940; the death rate was 18.8, giving a fatality rate of 2.8 per cent. From December 1, 1940, through July 31, 1941, 25 per cent of the Negroes rejected at induction stations were rejected because of venereal diseases; less than 5 per cent of the white rejections were for this cause.

It is a question whether poverty and public apathy or lack of education may account more for the poor progress made against these killers—poverty that malnourishes and lowers resistance to tuberculosis, or the poverty that prevents the state from adequately maintaining facilities for treatment and hospitalization. The indifference in regard to syphilis is leaving a poor paternity for the next generation since war selected the most fit.

VITAL STATISTICS FOR ATLANTA

Between 1930 and 1938, of the 41,777 resident births in Atlanta, 15,796 were Negro. Only in 1932 were Negroes born more rapidly than they died. The Negro vital index is 88.9 in Atlanta. In other words, it is biologically unhealthy. The chief difficulty is that Negroes die too fast, for the births for Negroes and the number of females of child-bearing age in proportion to population are above those of whites.

The ratio of illegitimate births among Negroes in Atlanta rose from 133.7 per 1,000 births in 1930 to 183.9 in 1938, while the ratio for whites declined from 26.5 in 1930 to 18.1 in 1938.

Six out of ten stillbirths in Atlanta were among Negroes; 78: 32 per 1,000 is the ratio of Negro to white. White infant mortality declined in Atlanta from 55.6 in 1930 to 47.5 per 1,000 live births in 1938. The Negro rate showed a greater decline during the period—from 147.3 to 88.6—but its rate approximates that of whites twenty-five years previously. The heavily populated Negro sections of the city provide most of the infant deaths. Seventy-three of 98 deaths from syphilis among infants of under one year of age were Negroes.

Mortality, illegitimacy, stillbirths and tuberculosis all are abnormally high in the ghettos of the state, usually higher among Negroes than whites—again reflecting the environmental difference. Census tracts of Atlanta reveal high morbidity and mortality in the slum areas of the city. Public health studies reveal that the low income groups have more illnesses and remain ill longer than higher income groups. With an average family income of less than $1,000 per year, the average Negro family's medical expenditure was $42.30 per year.

A larger proportion of the members of a family have to work in order to support a family in Atlanta than in any city in the South with a population of 100,000 or above. Low standards of living make people slum minded. Working parents and lack of recreational facilities make for juvenile delinquency. Dual justice in respect to Negro homicides encourages violence. Lack of the ballot and participation in the appropriation of tax money by the

Negro leaves his health and his education exploited.

WATERFLOW

The watersheds of the six drainage basins of Georgia have more than 50 inches of rain per annum. The Chattahoochee River has an average fall of 3.3 feet per mile for more than 200 miles. From all six drainage rivers there has been developed possibly half of the available 1,000,000 horsepower of electricity. The five cities with populations above 50,000 are situated on these rivers. Savannah, at the mouth of its river, is the only large city below the Fall Line.

Ninety-eight per cent of the surface water used for drinking purposes is treated to U.S.P.H. standards. Cities below the Fall Line use artesian water from deep wells. Most of this water is subsurface drainage from the regions above the Fall Line. For this reason sewage is not treated by the large cities on the Fall Line, but Atlanta does treat its sewage. Eighty-three per cent of all water used for drinking purposes is treated to U.S.P.H. standards. Coastal waters from calcareous rocks is hard, and that west of the Flint River from sand and silica beds is soft.

It is necessary to hold water where it falls for the growth of plants and to provide springs and the constant yield of water-power. Forest and grass cover and dams do this. For every pound of dry substance produced in a plant, several hundred pounds of water must pass through it and be given off through transpiration.

Rapidly draining surface waters carry tons of top soil from the land and cause gully erosion. About six thousand tons of water will fall upon an acre of land in a year when the rainfall averages 52 inches per annum. Six inches of topsoil on an acre of land weighs approximately one thousand tons. Uncovered land would merely have the topsoil displaced by water. The transportative capacity of a stream increases about a million times as its velocity increases ten times. Natural processes require a thousand years to replace several inches of topsoil.

Industry is partly restricted to regions of relatively cheap electric power and labor and transportation. High voltage can be transmitted about three hundred miles. Industry is above the Fall Line or on the Coast. The state is predominantly agricultural. Scientists can determine the quantity of available water that can be diverted to industrial use without impairing the vegetative and human needs of the state.

Lack of wealth in the community has prevented development of the full water-power or coal resources of the state, or the full utilization through industrial expansion of the energy resources already available. Here again is the vicious cycle of "poor land makes poor people; poor people make poor land."

IMPROVEMENT OF DOMESTIC ANIMALS

For southern temperature, special cattle must be bred. Grazing is interfered with in cattle not adapted to warm climates, and this interference reflects itself in milk production. The Jersey is quite well adapted to our climate. Beef cattle must be bred for quality of flesh and heat adaptation. The crosses between Brahman Indian and British beef breeds withstand high temperature, humidity, and insect infestations.

The Coastal Plain of the southeast is deficient in iron, copper and cobalt. This condition causes nutritional deficiencies in cattle, but can be corrected by feeding the elements to them.

Poultry and egg production may be increased by breeding, so that through biological production studies, we may obtain more for less and better adjust man to his environment.

EDUCATION

Illiteracy is high; 140 out of every 1,000 were rejected for this reason in the 1940–1943 draft. Twenty-four per cent of the

Negroes in the state who registered for the draft signed their cards with an X. The area is not now able adequately to educate its youth. Negroes are educated less than whites. The state's educational expenditure is $73.19 per white pupil and $16.55 per Negro pupil. The birth rate is higher than in other sections of the country; the trained individuals migrate to other sections to earn a livelihood. The entire area lacks technically trained people. The proportionate cost of education in relation to income is higher where the soil is poor and the people poorer. The education bought with this higher tax rate is less than that purchased by taxes from good lands.

INDUSTRY AND LABOR

Every effort has been made to keep a large pool of cheap labor available. Anti-union activity and anti-tenant association activity are normal patterns. Negroes are played against white labor, and both groups are kept in poverty. Despite the unsoundness of the propaganda, white laborers are taught to fear venereal contagion through use of tools which Negroes use. This prevents upgrading of Negroes in many industries, keeps the income of the area low (which in turn keeps consumption of manufactured goods low), and in part keeps some segments of the population poverty-stricken.

New technological methods of extraction of ores might enhance the value of the bauxite deposits in Georgia. Without that, either mills would have to be built near the ore deposits, or low cost transportation developed to get the ore to the mills. Similarly, clays used in paper manufacture could be used in the state instead of being shipped out of the state. The state loses the added value of manufacture.

Manufactured surpluses in the southeast are in textile products, tobacco and cigarettes, and basic lumber and timber products, including furniture. Deficiencies are in processed foods and feeds, nonelectrical machinery, and apparel. Also there are deficiencies in automobiles and parts, sheet and rolling mill products, and petroleum products. Georgia is twentieth among the states in the value of its manufactured goods and the value added from manufacture.

CONCLUSIONS

Lack of education, false education, and failure to implement the results of objective investigation in regard to land use, dual racial economy, health, housing, and industrialization pointing toward utilization of natural resources—these have made the area the number one economic problem of the nation. It is a tragic situation when viewed in the light of the state's original biologic and industrial potentiality. There is hope for recovery if, through education, the forces that shackle the area can be honestly faced and the necessary remedial measures applied.

Conservation measures for land, crop rotation, federal subsidies and control of education, granting of full citizenship to Negroes, and elimination of the one-party system in politics are means of improving the status of the area. Teaching the future citizens of our democracy the disclosures of science concerning man, and the interrelationships of men and the living and nonliving environment is a necessary function of general education. The application of the methods of science by these future citizens will correct many of the anti-democratic and wasteful practices of contemporary society.

FIRST- AND SECOND-GRADERS STUDY FOODS

LOUISE CROWDER
Simcoe School, Cullman County, Alabama

CHILDREN in many rural schools often eat hurried breakfasts or none at all. Lunches are brought to school and are sometimes so one-sided and unattractive as to take away appetite rather than encourage it. They usually consist of meat and bread-butter-and-sugar sandwiches; occasionally cookies are also included. In spite of the fact that their lunches are likely to be inadequate, many children have suppers of leftovers from the noon dinner at home. But a day at school is long and tiring, and children need nourishing food at every meal.

At the beginning of school last year, it was found that our first- and second-grade children usually had very inadequate breakfasts. Four of the thirty-one children customarily came to school without any breakfast at all. As a breakfast beverage, one child drank only water, one drank Postum, fourteen had coffee, three had cocoa, and only eight drank milk.

Better nutrition was a real need of these children. Consequently, an attempt was made to improve their daily diets through work in school. In connection with this attempt, the children participated in several kinds of activities: dehydrating foods; cultivating a fall garden; serving a hot dish at lunch time; experimenting with the nutrition of white rats.

DEHYDRATING FOODS

The community of Simcoe is located in a farming section. When school began last year, many fruits and vegetables were still plentiful. We started our work in nutrition by drying apples and green peas, for these foods were most plentiful and easiest for us to dry. Because a new dehydrating plant had just been opened in a neighboring town, we decided to give our foods the exalted name of "dehydrated foods."

As we observed our apples drying we found that they appeared to be "going away." One little boy who became much concerned about them advanced the explanation that someone must be eating them. Upon closer observation, however, the class discovered that the large, juicy pieces of apples put out to dry had become small brown pieces which rattled when shaken in a pan. They learned that the moisture in the apples had gone into the air.

Of course, the children eagerly discussed their dehydrated foods. From this it was but a step to discussing other ways of preserving foods. The children considered the different ways of canning of which they knew, and talked about reasons for preserving excess foods at home.

GARDENS AND HOT LUNCHES

Meanwhile, we decided to have a fall garden. A plot was chosen on the back campus. Hoes, rakes, and picks were brought from home. Children used their wagons to haul compost from barns. Parents gave seed. We planted turnips, radishes, mustard, lettuce, and tender greens. The children worked eagerly and watched for every little change that took place as the plants developed. As a result of their work they were soon able to have greens to supplement their lunches. Since radishes, lettuce, and tender greens can stand less cold than turnips and mustard, they were used first.

Of necessity, the school garden was small. The work was done by hand by small children. However, its influence was great. Parents realized that by making their own gardens larger they could supplement the produce of the school garden. Each parent who had extra garden space planted some greens to be taken to school.

Soon the children were bringing other foods to school as well: canned tomatoes, beans, and peas; dried peas and beans;

eggs; and the like. It became possible to serve a hot dish at lunch time daily. A plan was worked out whereby each child contributed what he could when it was needed.

AN EXPERIMENT WITH WHITE RATS

Among the possessions of the class was a family of white rats. At first the rats were no more than a novelty to the children—new pets to be handled and cared for. While considering the care of the rats, the children learned that, with respect to food, at least, the needs of rats and the needs of children are similar. Soon the class realized that the rats could serve a more important purpose than merely being pets; they could be used to help the children in their study of foods. As a result, diets were decided upon for the different rats: diets for the most part identical with the breakfasts eaten by the children. One young rat was fed on biscuit, butter, syrup, and water; another was given biscuit, syrup, and coffee; a third was given biscuit, syrup, and coffee with the addition of water and peanuts (as a meat substitute). The father rat was fed on biscuit, peanuts, cocoa and water.

Two rats, the mother and one of the young, were fed a varied diet, as follows:

apple core, orange slice, end of banana
oatmeal, mixed grains, bread, biscuit, cornbread, cookies
boiled egg, peanuts
raw lettuce, carrots, turnips, potatoes
cooked vegetables
milk
water

The young rat fed on biscuit, syrup, and coffee showed symptoms of poor nutrition in two weeks. Redness appeared over one eye and both eyes were watery. Soon one eye was closed. In three weeks both eyes were closed and in four weeks the rat was dead.

The other rats on inadequate diets survived, although they, too, gave evidence that they were poorly nourished. At the end of five weeks, their hair was standing out from their bodies. They were lazy and sluggish and slept most of the time. Their appetites were gone and they had almost no use of their legs. Only one had gained weight—the weight of the rat receiving biscuit, syrup, peanuts, coffee, and water had increased from one and one-half ounces to two and one-half ounces.

In contrast to the father rat and his inadequately fed offspring, the well-fed mother and young rat were obviously healthy. Their hair was smooth and glossy; it also looked exceedingly white. They were lively; their eyes were bright and clear. They ate as if they enjoyed their food. The young rat had increased in weight from two ounces to five ounces.

All the rats were now given the varied diet. Cod-liver oil was added to their milk. In a week the health of the malnourished rats had improved considerably.

The effects of diet on the rat body were evident. We decided that foods affect our bodies, too. The following questions arose as the children observed the rats eat their food:

1. What foods do children need daily?
2. What foods do father, mother, big brother, big sister, soldiers need in their daily diet?
3. Why does everyone need milk?
4. What different kinds of foods do we need?

SOME RESULTS OF THE WORK

Not only did the children gain in understanding of the nature and importance of adequate diets, but their behavior changed, largely as a result of the hot lunch program. Many children learned to eat foods they had not liked before. They acquired the habit of washing their hands before lunch, and in general gave evidence of realizing the need for cleanliness in handling foods. Their manners at table improved,

and they ate their lunches more slowly.

Their learning carried over into their homes, too. Apples and oranges appeared in children's lunch boxes. Parents planted larger gardens that their children might have more vegetables, and ordered government materials on foods. Foods and lunches were discussed at P.T.A. meetings.

DO TEACHERS CONSIDER SUGGESTIONS FOR TEACHING?

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A BELIEF which is gaining increasing acceptance among educators is that teachers work most effectively when they have abundant resources of methods and materials which they adapt to specific teaching situations. This philosophy represents a break from the belief that detailed plans for teaching made by any one outside the actual teaching situation—be he textbook author, member of a board of public instruction, superintendent of schools, or director of curriculum—can be of much value. The prescriptive syllabus, which specified topics to be taught and a time schedule to be maintained, was once characteristic of some educators' thinking. In many school systems, however, the prescriptive syllabus has been displaced by suggestive helps for teachers. Such contemporary courses of study warn that extremely poor teaching may result from rigid adherence to any plan made outside the teaching situation. But they also require teachers to accept responsibility for formulating objectives for their teaching and for carrying out with their students activities designed to accomplish those objectives.

To assist high school teachers of physical science to engage in the kind of teaching appropriate today, a suggestive guide was prepared in the field of electricity, a guide which was intended to help secondary school and college teachers use their knowledge about electricity to achieve purposes that are immediately functional in the lives of young people and the communities in which they live.[1]

Organization and Content of "Suggestions for Teaching Electricity"

The first chapter of the monograph begins with a discussion of energy resources and points up with statistics the great and increasing use of electricity. It continues with a discussion of the effects of the extension of the use of electricity on the problems that persistently challenge individuals and society. Chapter II reports some generalizations concerning students' interests and knowledge in the several problem areas, and suggests methods teachers may use in investigating the interests and knowledge of the individual students in their classes; the chapter is based on the premise that teaching is better when directed so as to expand students' interests and socially acceptable ideas and to correct misconceptions and antisocial tendencies.

Chapter III presents teaching objectives which are important in a study of electricity; these objectives are derived from deliberate consideration of the needs of society and the needs and interests of young people. The fourth chapter suggests specific activities which are useful in initiating a study of electricity, and the fifth chapter sets forth a number of activities for continuing a study which is already under way. Each of the latter two chapters emphasizes the importance of studying the local electric utility.

Chapter VI asserts that evaluation should be in terms of all the objectives which a teacher has accepted for his work, not just the knowledge objective; it also points out that appraisal techniques are valuable

in directing and improving teaching, as well as in assigning marks to students; finally, it suggests specific procedures and illustrates them. In Chapter VII the theory, construction, and use of electrical measuring instruments are presented; the quantitative aspects of electricity are dealt with in the light of the nature of the problems which come into the lives of citizens of the modern world. Finally, there is a classified and annotated bibliography eight pages in length.

THE DISTRIBUTION OF THE MONOGRAPH

The Weston Electrical Instrument Corporation of Newark, New Jersey, undertook to distribute copies of the monograph free to teachers in service who requested them and who named their school connections. Its availability was made known by the activities of the Corporation's representatives in various regions of the country and by a mailing piece sent to schools throughout the United States. More than 7,600 announcements were mailed.

Fourteen months after the monograph was announced, a check-up was made which showed that a total of 3,712 identified individuals had requested a copy of the "Suggestions." About 70 per cent of these, really 2,611, were directly concerned with classroom teaching. As there are probably some 16,000 physical science teachers in the American high schools (an estimate based on data from the National Survey of the Education of Teachers [2] and on reported student enrollments in science classes [3] it is evident that requests had come from about 16 per cent of the teachers for whom the monograph was designed.

Although 16,000 physical science teachers constitute the gross potential reading public of *Suggestions for Teaching Electricity,* the net potential market was probably much smaller. This is suggested by the plausible assumption that general science teachers and teachers of chemistry, included among physical science teachers, have less interest in the material of the monograph than have physics teachers. Another pertinent factor is possible lack of interest in the part of individual teachers. The number of professionally alert physical science teachers—of teachers who might be expected to welcome an opportunity to see the suggestive guide, whether they used it or not—was estimated from the circulation of professional journals to be only about 1,500. The number of identified teacher recipients of the "Suggestions" was over 1.7 times that figure.

RECIPIENTS' OPINIONS OF THE MONOGRAPH

An effort was made to discover what use was made of the monograph by the teachers who received it. A part of this effort consisted of a questionnaire study of their reactions to the volume. Respondents were asked to rank the several chapters of the monograph for their relative values to teachers.

Study of the returns showed that the mean ranks assigned distinguished reliably among the several chapters, whose titles are:

I. Importance of Studying Electricity
II. Students' Interests and Knowledge
III. Objectives in a Study of Electricity
IV. Suggested Approaches to Teaching about Electricity
V. Suggested Activities in a Study of Electricity
VI. Suggestions for Evaluation in Electricity
VII. Electrical Measuring Instruments

Chapters IV and V, which were alike in containing numerous suggestions for teaching and learning activities, practically tied for highest rank. Chapters II and III, which were alike in dealing with wise selection of teaching objectives, immediate and ultimate, ranked next. Chapters I and VII were judged equally worthy of the next rank, while Chapter VI, which consisted of suggestions for evaluation, was considered least valuable.

No variation in chapter rankings was

found to be associated with the length of the respondents' teaching experience. This meant, for example, that the more experienced teachers had given just as high rank to the specific suggestions for teaching activities—Chapters IV and V—as had less experienced teachers.

In ranking of chapters there were some differences which correlated with respondents' major teaching subject. For example, Chapter VII, Electrical Measuring Instruments, was given approximately equal numbers of high ranks and of low ranks by teachers of physics, chemistry, and physical science; by general science teachers, however, it was given many times more low ranks than high. Chapter I was given a relatively higher ranking by general science teachers than it was by others. These differences were believed to be in keeping with the conception that general science teachers devote more attention to general education than to technical subject matter.

Respondents in three communities—some forty in number—were visited and interviewed. It was found that the high value assigned to Chapters IV and V by rankings on the questionnaire was supported by the comments of those interviewed. These teachers stated that they wished suggestions for increasing students' understanding of various subject-matter topics which they thought had been omitted. (It might be noted here that the stated purpose of the monograph was not to cover the field but "to help teachers select and arrange materials from the vast accumulation of knowledge about electricity.") Teachers also wanted more suggestions for activities, demonstrations, and construction of apparatus, even for topics for which some such suggestions had been given.

When the teachers interviewed were asked what kinds of helps they would prepare for the use of teachers, they answered in effect, "Materials closest to the forms in which they are to be used." Of the materials in the monograph, the suggestions in Chapters IV and V for teaching and learning activities were closest to what teachers do in the classroom. The other chapters could only guide teachers to make wise use of the activities that were suggested and to devise other such activities.

Rankings assigned to chapters, comments on omissions, characterizations of helps which those interviewed would prepare for their fellow teachers—none of these had any necessary relation to the actual use made of the "Suggestions." Therefore, special attention was paid during the interviews to the influence of the material on teachers' practices. Of several teachers who said their work was hampered by lack of equipment, not one commented on the various detailed suggestions for constructing or securing electrical equipment. One teacher who said he wanted help in evaluation did not refer to the chapter which gives specific examples of many kinds of test items in electricity and also cites more general sources of help in evaluation. Even teachers of physical science courses designed for nonacademic students—courses which are often built on cultural materials drawn from the community—did not indicate that they had followed suggestions in the monograph such as those concerning the electric utility.

Neither had those interviewed permitted two specific recommendations made in the monograph to affect their teaching noticeably. The first of these recommendations was that instruction should be directed with due consideration for the needs and interests of individual students. As far as was determined, only one teacher made anything like a systematic effort to discover what her students wanted and needed to know, and she had been doing this before she saw the monograph. An understanding teacher may acquire, during years of teaching, a general knowledge of the range of interests and needs students have, and may draw on such knowledge in planning his

work. But many of those interviewed were not convinced of the wisdom of even this latter procedure.

The second recommendation considered was that the local electric utility be employed as a source of illustrative and problem material. Factors in the local electric utility were widely different from one community to another—as the investigator confirmed by a series of interviews with spokesmen for the industries—and might have been used effectively in teaching. One system was part of a great power pool; another was relatively isolated. Rates paid at the level of mean domestic consumption varied from 3.1¢ to 4.1¢ to 5.1¢ per kilowatt-hour. In the same order, mean domestic comsumptions were 78.8, 74.7, and 62.8 kilowatt-hours per month.

Teachers varied in knowledge of their local electric utility; a few, chiefly in junior high schools, had studied with their students how to read meters and compute monthly bills. However, there was no evidence that any teacher's practice in this respect has been changed by his reading the monograph.

The monograph is a source of both objectives and activities. Ideally it requires teachers to choose activities in the light of objectives they have adopted. As factors preventing the ideal use of source materials, the teachers who were interviewed cited the following: teachers who teach outside their major and minor areas of college preparation, teachers whose daily preparation for teaching must be spread over several subjects, and even teachers who are lazy. They appeared to believe that the ideal situation was not often realized, and that materials in other forms, especially textbooks, probably have more effect on teaching than do source materials.

INTERPRETATION OF THE FINDINGS

Teachers who were interviewed had been free to use the ideas in the "Suggestions for Teaching." They had not been hampered by prescriptive courses of study, achievement testing programs, college entrance requirements, administrative policy on teaching about contemporary issues, or the like. The teachers who were not following the recommendations of the monograph in the particulars mentioned above were abstaining because they did not want to do those things.

The study here reported was limited to the influence of the monograph on the practice of teachers in service, teachers actually concerned with work in classroom and laboratory. No attempt was made to identify its uses in the preservice education of science teachers, although its detailed suggestions for implementing the philosophy of general education in one field could be very helpful in leading prospective teachers—as well as experienced teachers—to see what can be done within the existing school situation in working toward revised objectives. Nor was any effort made to determine its usefulness to curriculum committees, whose members might be expected to have the time and the desire to study its ideas and to employ them in preparing courses of study and other curriculum materials. And no attempt was made to discover any influence it might have had on the writing of textbooks, although any changes in textbooks would probably greatly influence classroom procedures. The investigation which was made, however, indicates how difficult it is to get teachers in service to consider suggestions about the teaching process.

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MEETING A WAR-TIME EMERGENCY

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WHEN schools opened in September, 1943, the State Teachers College at Towson, Maryland, was suddenly called upon to supply approximately twenty elementary teachers for new schools which had been constructed nearby in the vicinity of huge defense plants. The problem was not simple, for the college had already taxed itself to meet the existing shortage of teachers. All recent graduates had long since been placed and many seniors had been sent out on "internships" under supervision. There would be no more graduates until the end of the semester.

The short notice and the urgent need for teachers greatly complicated the problem. Twenty classes of forty to fifty children each were waiting for teachers—children from ten or more states whose parents had come to work in the defense plants. A hasty survey of the possibilities at the college revealed that the only resource was a group of junior students who might be able to go into these schools and willing to try to meet the emergency.

The proposition was put to them fairly and squarely. Such a move was not compulsory. It would delay graduation and would involve much extra work of the hardest kind. The response was splendid. Students with no practice teaching experience, few courses in the teaching of various subjects, and no opportunity for special preparation, were taken literally fresh from college classes, and each was given a grade to teach. It took courage for them to face the situation.

THE PROBLEM

The problem of the college was to direct the work of these students so that neither they nor the children in their charge would suffer from the experience. It was decided (1) to provide the student teachers with expense money, since they were not qualified for any kind of teacher certification, and (2) to provide faculty assistance so that college credit could be given for the usual required practice teaching and for certain education courses, such as those in the teaching of specific subjects. In effect, new college courses were developed as the students' work with children progressed. There was no time for speculation as to which methods might be best, and the results of the courses showed immediately with children in the classroom. The material had to be practical—it had to work.

The teaching the college students did involved all that is usually done in elementary grades. The schools in which they taught had been newly constructed by the United States Government to meet an emergency situation. The buildings were adequate, but there was no equipment of any kind—and in science, no books of any kind. This latter fact was probably in many ways a blessing in disguise, for the science work certainly could not be "textbook science." Later, however, books to enrich the science experiences were provided as fast as they could be obtained.

THE APPROACH

With one exception, the students taught in the first four grades. A general supervisor was provided for grades one and two and another for grades three and four. In addition, one college instructor from each of the subject-matter fields was assigned to help in his special area. The type of assistance given was not supervision in the usual sense; it was practical aid in planning subject matter, providing materials, and

actual teaching. For example, in the early stages of the project, it was not at all uncommon for supervisors and college instructors to teach for college students when they needed help. Instructors often found themselves tactfully taking over a class in order to turn the tide of the lesson in the desired direction and just as tactfully giving the class back to the student teacher when things were progressing well. Such experiences created a feeling of fellowship between faculty and students which possibly could not have been achieved in any other way.

Instructors were on call for night conferences and for Saturday work with the students if there was need. However, care was exercised not to overburden the students with too much work of this kind.

SCIENCE WORK IN GRADES ONE AND TWO

To show the kind of science work attempted, a brief description of the first unit for the lower-grade group is presented. This unit was *How Do Living Things Get Ready for Winter?* It was selected because (1) the student teachers had fairly good subject-matter backgrounds for this type of work, and (2) the lack of equipment of any kind made necessary the use of environmental material. It should be noted that the environment was particularly favorable for teaching the unit selected.

The students teaching first and second grades met with the college instructor to plan the unit. In the course of the planning, they became acquainted with the subject matter, materials, and methods of presentation which could be used. It was decided to use the same unit with both the first and second grades to save time in planning, since only one college instructor in science was available. The level of teaching was, of course, adapted to the abilities of the children in each grade.

A skeleton outline of the main ideas of the unit and things to do to put these ideas across follows.

How Do Living Things Get Ready for Winter?

I. How do we know that winter is coming?

Main ideas the children should get

There are four seasons.
Autumn follows summer.
In autumn days grow colder and shorter.
We wear heavier clothes in autumn.

Things to do to help the children understand the main ideas

Discuss what games can be played in hot weather but not in cold weather and why these games are played in each kind of weather.

Familiarize the children with the names of the seasons. Mount magazine pictures illustrating each of the seasons. Have the children identify these and tell what they like about each season.

Make a large demonstration thermometer and teach the children how to read it. If they have not mastered numbers yet, teach that when the thermometer is rising, the weather is getting warm; when it is falling, the weather is getting cold. Use the real thermometer in the room. Show the children how to read it. Show the room temperature on the demonstration thermometer. Stress freezing point, body temperature, and proper room temperature.

Make a weather chart and record the outside temperature each day for several weeks. Discuss from time to time the increasing cold. Mark important happenings such as frost on the chart.

Take walks with the children. Observe evidences of seasonal change. Discuss how we know that winter is coming.

Check-up

Have the children draw pictures of autumn subjects. Let each child explain what his picture shows. Display the pictures on the bulletin board.

Make a reading chart and use it in class. Let second-grade children read selected stories that supplement what they have learned about "How we know that winter is coming."

II. How do plants get ready for winter?

Ideas the children should get

Plants stop growing and change color.
Plants make fruits and seeds that start new plants when spring comes again.
Leaves fall from some trees.
Some trees stay green all winter.

Things to do to help put across the ideas

Have the children make a leaf book of color leaves as a class project. Have the leaves mounted on colored paper, and the sheets either bound into a

booklet or posted on the bulletin board.
Let the children make colored drawings of autumn leaves. Use a variety of leaves. Label the drawings with the names of the kinds of leaves used, if possible.
Use bouquets of colored leaves as schoolroom decoration. (Caution the children about indiscriminate picking.)
Visit the out-doors with the class and note that the grass is brown.
Make a class seed collection, putting seeds in small boxes, bottles, or cellophane envelopes for display. (Direct special attention to the fact that seeds do not freeze. They grow into new plants next spring. This is a way in which plants survive winter.)
Bring to school any autumn fruits and vegetables which can be obtained: ear of corn, small pumpkin, cucumber, potato, and the like. Display these and have the children tell stories about them.
Make and use reading charts about autumn fruits and vegetables.
Have the children model autumn fruits from clay and color the models.
Discuss the fact that trees do not die in winter even though their leaves fall.
Bring specimens of evergreen branches to school. Stress the fact that evergreen leaves do not freeze, but stay on the trees during winter. Show pictures of evergreens and discuss their uses.
Let the children construct on the sand table a scene showing how it looks outdoors in the autumn.

Check-up

Let the children give oral summaries of how plants get ready for winter. Write some of their important statements on the blackboard. Have the class read these statements.

III. How do animals get ready for winter?

Ideas the children should get

Animals get ready for winter.
Some birds and butterflies (the monarch butterfly, for example) go south.
Some animals hibernate (frog, bear, woodchuck).
We can see some animals all winter (squirrel, rabbit, some kinds of birds).

Things to do to put across the ideas.

Let the children watch and discuss squirrels and other animals that store nuts for the winter. If observation is not possible, use pictures to stimulate discussions.
Discuss the fact that animals' fur gets heavier in autumn.
Have the class collect caterpillars, put them in terrariums, and watch to see whether cocoons or chrysalises are formed. Tell stories to illustrate the way animals survive the winter by this method.
Post pictures of birds that migrate. Familiarize the children with the names of these birds. Have them watch for bird migration, especially for the migration of geese.
Tell stories, show pictures, and lead discussions of animal hibernation. Choose several typical animals, including the toad.
Discuss the kinds of animals that hunt for food all winter—rabbit, deer, wolf. Contrast them with animals that store food.

IV. How do we get ready for winter?

Ideas the children should get

People wear warm clothes in winter.
People keep their houses warm in winter.
People store food for use in winter.

Things to do to help put across the ideas

Bring samples of summer and winter clothing materials to school. Display and discuss them.
Discuss why we sometimes wear overshoes, raincoats, and rain hats.
Discuss how winter clothes are made differently from summer clothes (for example, with long sleeves).
Direct attention to out-of-school observations of harvesting. List kinds of crops, such as corn and hay, and have the children tell how crops are harvested and stored. Discuss uses of stored crops during winter.
Let the children draw pictures of harvest scenes.
List vegetables that can be dried and kept during winter. List others that are kept in cellars without drying (pumpkins, apples).
Discuss meat preservation as a method of supplying food for winter.
Discuss kinds of foods which are canned.
Discuss the storing of coal, oil, and wood for fuel.

Complete freedom was given the student teachers to draw from the different divisions of the outline, to proceed at their own rate in developing the unit, and to organize the work to suit the needs of their own groups as these could best be determined. This freedom proved to be a good procedure. Even though the various teachers were attempting to put across the

same ideas, each teacher did it in her own way.

Diary records were kept by each teacher to record her "ups and downs" and to show the direction and progress of her work. These records provide interesting reading. The following excerpt from one of them describes an experience some children had:

> Today we talked about the temperature inside the house and outside. The children wanted to know how the room was heated. We visited the boiler room to find out. We also talked about where coal and other kinds of fuel come from. The children told how their homes (in some cases, trailers) were heated.

Another entry from a diary record shows a different kind of activity:

> The children fixed a terrarium after one of them had brought in a toad. They learned the names of some of the plants, such as swamp grass and moss. We discussed the differences between a toad and a frog and discussed what toads eat. We planned to feed the toad and watch it go into hibernation.

Near the end of the unit, the student teachers, in conference with the college science instructor, prepared simple tests to be given to the children. While these tests served as a kind of check on what the children had gained, they were principally a means by which each teacher could check up on her teaching. (The children's marks on these tests were not used by the college instructor as a means of rating the individual student teachers or of comparing their work.) Incidentally, the results of the tests were particularly gratifying, because in almost every case the children did better than the teachers had expected them to do.

The next unit selected for the two lower grades was a study of weather. This unit was selected by the teachers because it was a natural outgrowth of the previous unit and because it fitted in with a social studies unit which was being planned. Planning, organizing, and outlining was better on this unit because of previous experience. Preparation for teaching was done in Saturday classes where any necessary subject matter was taught and apparatus was constructed and tested. As before, a check-up was given at the end of the unit to help the teacher evaluate her teaching.

The last unit—three rather long ones were taught during the course of the school year—was one of the individual teacher's own choosing. She was placed entirely on her own for all organization, securing of materials, and means of presentation. The aid of the instructor was available whenever desired, of course. By this time the teachers had matured sufficiently to be allowed to "try their wings" unaided.

SCIENCE WORK IN GRADES THREE AND FOUR

The same procedures were followed with the teachers of the third and fourth grades as with those of the lower grades. The first unit selected was *How Do Scientists Put Living Things into Groups?* This unit was thought to be appropriate because (1) the teachers had good subject-matter background for it, (2) it used environmental material, and (3) it placed stress upon the scientific method.

Since the planning and developing of a unit for the lower two grades has been described in some detail, a few suggestions as to what was done with the upper grade unit will be sufficient.

The children were asked to bring to school such things as leaves, sea shells, and rocks, that they had collected. Informal discussions were held about these objects—what they were, where they were secured, and other interesting points. All the objects were placed upon a large table and the children were asked to arrange them into groups of *living things* and *nonliving things*.

The procedure which followed was the separation of the living things into groups on the basis of easily notable structures and characteristics. Animals were grouped as mammals, birds, reptiles, fish, amphibians,

insects, and a few others. Plants were separated into two groups: those which produce flowers and seeds, and those which are non-flowering. Living specimens were used wherever possible. The response of the children in bringing to class and handling the specimens was one of the outstanding features of the unit. At all times, the main emphasis was placed upon *how* the specimens could be put into their proper groups, rather than upon mere identification. Much incidental work was done in studying the economic importance of the specimens—their relation to their habitats. As with the lower grade groups, check-up tests were given at the end of the unit to help the teachers evaluate their work with the children.

The second unit selected for the upper grades was *How Do Machines Help Make Work Easier?* This unit was chosen because (1) it offered a number of possibilities for the children to use and understand such simple machines as are found around their homes, and (2) it fitted in with their work in social studies. The preparation for this unit was done by the teachers on Saturdays and consisted of reviewing the necessary subject matter, constructing simple equipment, and becoming familiar with experiments which could be used with the children.

As with the lower grades, each teacher of this group selected the unit she wished to teach for the third and last of the year, and assumed the initiative for preparing and presenting it.

EVALUATION OF THE EXPERIENCE

This undertaking met a war-time emergency by providing teachers who would not otherwise have been available. It enabled college students to serve in an emergency while gaining valuable experience and earning college credit. The experience gained by the student teachers was probably of far more value to them than experience gained from the usual practice teaching and from ordinary courses in the teaching of subject matter. The maturing of the students was most pronounced in their increasing ability to understand children and in their improving techniques of teaching. Their individual differences could be noted and their particular needs cared for to a degree not possible in regular college work. Student-instructor relationships of the highest quality were developed. The experience helped instructors make their usual college courses more practical.

Chief weaknesses were lack of time on the part of the student teachers for preparation which would enrich their teaching, and on the part of the instructors for work with the student teachers during their actual classroom teaching. The undertaking was very expensive of the instructors' time. It limited the number of other college duties which could be carried on during the year.

The student teachers and the college instructors agree that this project involved the hardest work they ever did, but that the valuable experiences which were gained made it well worth while. The students deserve much praise for their fine response in meeting a difficult situation.

IS YOUR STATE DISCOVERING ITS SCIENCE TALENT?

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HOW does your state compare with others in science talent?

Whether you are from the North, East, West, or South you probably have a certain "state pride" and are convinced that the sons and daughters from "Old Califchusetts" are far superior to those from other states. Naturally they can do better than others. But do they always get the chance? In this matter of science talent, for example, do they know their opportunities—that the very best of them can win science scholarships that will help them to become the really great scientists of tomorrow?

A partial answer is given in the results of the Annual Science Talent Search. Certainly there are brilliant boys and girls in *every* single state in the Union, but how can we find them? That is the question. And here are the facts.

For three successive years a nation-wide Science Talent Search has been conducted in the high schools of the country, with some twelve to fifteen thousand high-school seniors participating annually. But certain states consistently fail to have top contestants.

Each year approximately 3,000 students have completed entries—including a science aptitude examination, a personal data blank, a high school record, and a scientific essay—and of these, 300 boys and girls have been given Honorable Mention. The proportion of girls to boys selected is the same as the proportion among the participants who submit complete entrance materials. Forty of these 300 seniors have then been brought to Washington, D. C., to compete for the two $2,400 Westinghouse Grand Science Scholarships, and other trip winners have been awarded from $100 to $400 Science Scholarships granted by the Westinghouse Electric & Manufacturing Company. The contest is conducted by Science Clubs of America, and administered by Science Service. *The names of the contestants and the geographical localities represented are not known by the judges in selecting the 300 Honorable Mentions, or the 40 Washington trip winners.*

Ideally, then, you might assume that the number selected from each state would vary according to the number of high school seniors. For example, in a state with 8 per cent of the high-school seniors of the country you would expect to find approximately 8 per cent of the Honorable Mentions. But the accompanying map, Figure 1, shows that this is not the case. Wisconsin, for example, in 1940 had 2.62 per cent of all high-school seniors, and so theoretically should provide 2.62 per cent of the 300 honors group each year, or about 8 students. Yet actually Wisconsin has produced an average of 15 Honorable Mentions each year!

How does your state compare on this map with other states? This is a significant question, since the Science Talent Search has been equally publicized in all

* The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

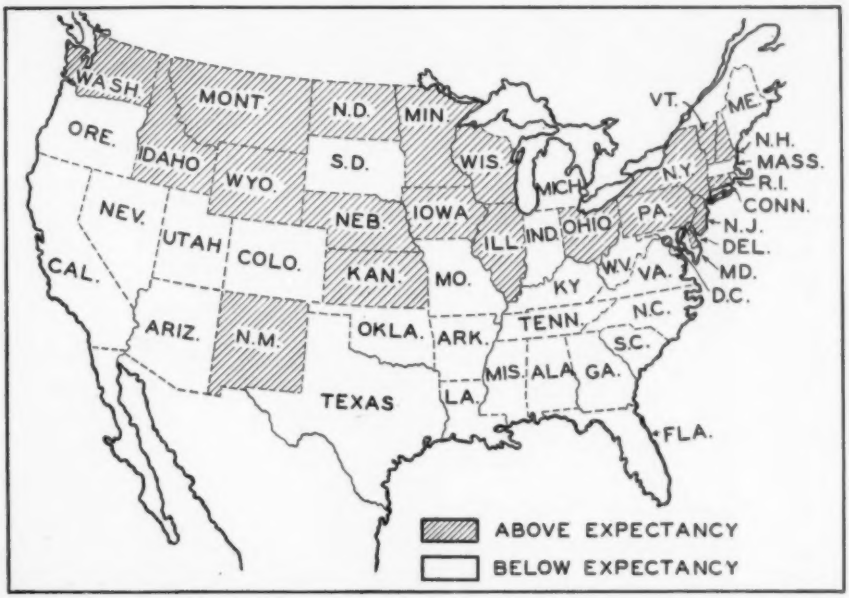

Fig. 1. Honorable Mentions (Averages of First, Second, and Third Science Talent Searches) from Each State above and below Expectancy Based on High School Senior Population.

states, and since announcements and contest rules have been sent each year to every high school and secondary school in the country, public, parochial, and private. The differences among the states in percentages of winners and Honorable Mentions are considerably greater than would be expected statistically by chance.*

Having an outstanding number of winners is partially a function of having a large number of participants—see Figure 2. This chart shows the states ranked by participants per 1,000 high-school seniors. For example, the shaded portion of the top bar indicates that for the three years an average of 4.4 per 1,000 seniors in New Mexico completed entries in the contest, whereas the shaded portion of the bar next to the bottom shows that North Carolina has had an average of only 0.6 participants per 1,000 high-school seniors for the three years. The black portion of the bars shows the average number of Honorable Mentions per year per 1,000 high-school seniors. Thus, 0.29 per 1,000 New Mexico seniors have won honors, and 0.45 per 1,000 Wisconsin seniors; as contrasted with 0.02 in North Carolina, and none at all in Nevada.

In Wisconsin and North Carolina, each of which had approximately 35,000 high-school seniors in 1940, theoretically there should be equal chances in the Science Talent Search. But in Wisconsin there has been a total of 1,402 requests for the three years for entrance materials, and 433 seniors have actually filled out the materials completely; whereas in North Carolina there have been only 758 requests in the entire three years, and only 70 seniors have completed entries. The results are significant: Wisconsin has had 45 Honorable Mentions and 9 trip winners; North Carolina has had only 2 Honorable Mentions and no trip winners.

* This statement is based on a computation of the ratio of the sum of the square of the values about their means to the standard deviations of an equivalent Poisson series. See Rider, Paul R. *An Introduction to Modern Statistical Method*, Formula 12, p. 105. John Wiley and Sons, Inc., New York, 1939.

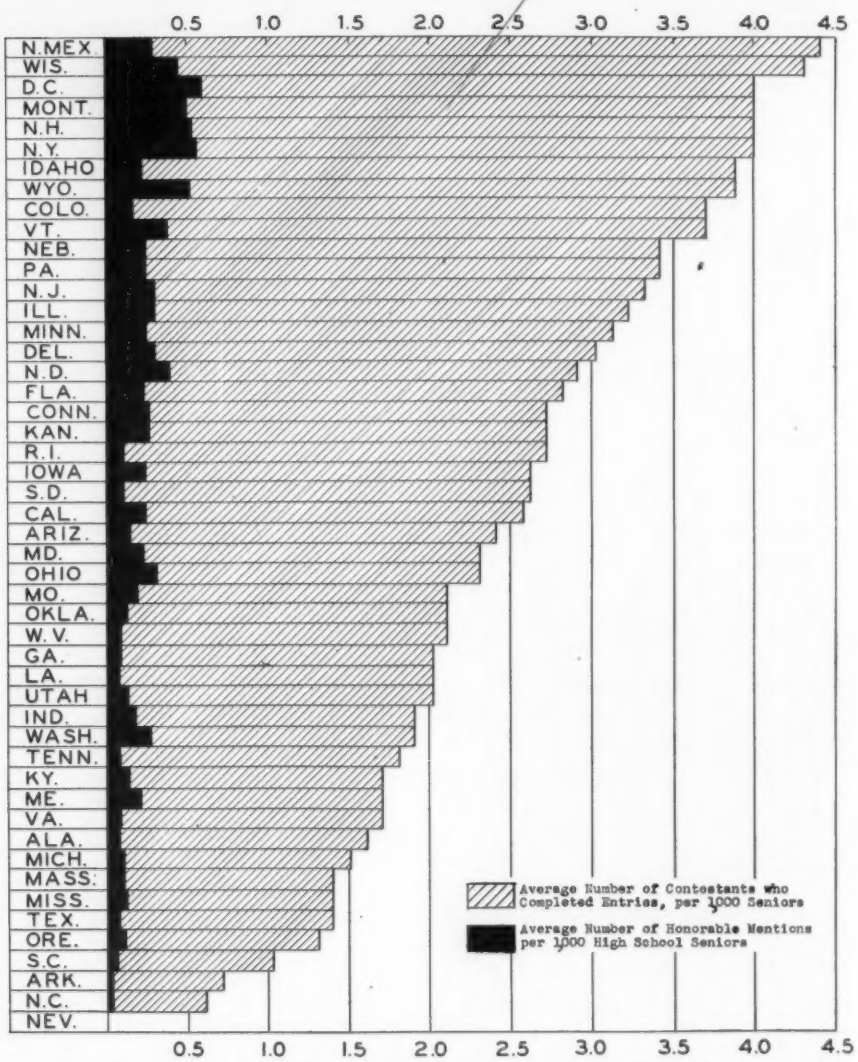

FIG. 2. States Ranked by Average Number of Contestants per 1,000 High School Seniors in First Three Science Talent Searches.

The 120 actual trip winners—40 for each of three years—have also come predominantly from a relatively few states. Exactly 40 of the winners—one third—have been from New York State, although according to the ratio of its population of high-school seniors New York theoretically should have had only 12 winners in the three years. Of the six winners of top scholarships, one each of the three years has come from New York!

Even though a contestant does not win top place or even a trip to Washington, practically all of the 300 Honorable Mentions each year have been offered substantial scholarships at leading colleges and universities. In a follow-up study of all the contestants in the first year, 77 boys and

23 girls of the Honorable Mentions reported scholarships from various sources aggregating $70,000.

The Fourth Annual Science Talent Search is now under way. Each contestant must take the Science Aptitude Examination administered in his school, and all entries must reach Washington, D. C., not later than midnight Friday, December 29. Details and complete entry materials can be obtained from Science Clubs of America, 1719 N Street N.W., Washington, D. C.

The question is—are the high-school seniors in your state being given their chance? Are their teachers doing their part to locate and encourage the future scientists of our nation?

SYMPOSIUM: HOW CAN SCIENCE EDUCATION MAKE ITS GREATEST CONTRIBUTION IN THE POST-WAR PERIOD?

PREFATORY STATEMENT

I think we all realize that the problem of how science education can make its greatest contribution in the post-war period is probably the most serious one that confronts the science educator.

The quickened interest in education, generally, and the widespread acceptance of the principle that the hopes of the future depend more than ever before upon education, induce the consideration of science education as an integral part of that system and of the ability of science education to meet the demands of the post-war society. That interest has been strongly reinforced by the role science and the scientific training of youth are playing in the war, as the proceedings of military and civilian committees or the most casual survey of the immense literature on war and post-war planning will attest. Still further, and more urgently, attention of science teachers and educators needs to be focussed from the point of view of the facilities of schools to meet the country's need for the scientific training of youth for participation in the post-war world as citizens as well as in regard to the training of greatly increased numbers of research workers and other scientifically trained personnel that will be required after the war.

On all these counts and also on others, there is urgent need here and now for the clearly considered judgment of science teachers and educators in anticipating post-war educational problems and formulating plans for their solution.

The issues discussed in this symposium likely vary widely in importance and urgency. They range from details of teaching methods to the ultimate functions of the schools. The issues raised by the contributors may be placed in four main groups:

1) The objectives of science education
2) The content and organization of the educational program
3) The permanency of new subjects in science introduced by the wartime program
4) The selection and preparation of teachers of science

There are first the fundamental questions as to the aims and purposes of science education and the extent to which previously formulated objectives need to be modified to meet better the new needs and the new times. We find under this category such issues discussed as the need for more mastery of knowledge on the part of the students, renewed emphasis upon understanding the scientific method and developing skill in problem solving, the inculcation of scientific attitudes, and increased attention to the role of science in general education.

The proposals for the instructional program include recommendations for a type of program organized around problems of contemporary life, specific plans for a continuous program in science throughout the elementary and secondary schools, the design of four one-year core courses in secondary school science, and the differentiation of the science curriculum into pre-professional science courses and courses for general education.

Among the predictions made are that certain of the new subjects introduced into the wartime program will be continued, that accelerated programs in science as in other fields will need to be provided at the high school and college levels, and that there will be compulsory military training for young men of college age, which will require a background of science and will comprise further training in special fields of applied science.

Finally, prominent attention is given to the highly significant problem of the selection and training of prospective teachers of science who are capable of fulfilling the exacting requirements and of meeting the challenge of science in the new education.

In the long run, the answer to these questions must determine the content, scope, and effectiveness of the science education of the future.

On many of the questions raised it is doubtful whether or not we have or can secure sufficient

data for final decisions, and there is an admirable note of caution sounded by some of the contributors in regard to such matters. Creative thought cannot be forced. Perhaps all we can look forward to accomplishing in the near future is such reconstruction of our educational framework that stimulates creative forces by encouraging experiments originating in the needs of the transition period. We should be on our guard that changes designed to meet immediate urgent needs should not be of such nature that they might obstruct more significant changes or developments which further research may deem necessary.

The adjustments made to make science education more effective during the war should promote experimentation and keep us ever attentive to the fact that science education, as well as all education, must be kept dynamic if it is to continue in living contact with the society it claims to serve.

We have the great good fortune to have contributors who are well known, I think, to readers of SCIENCE EDUCATION—well known for their distinction in the field of science or in science education. The symposium provides, therefore, a unique opportunity for telling us something that is of weight on the subject which is before us. Ideas with hands and feet are presented. It behooves all of us to see that they are brought to bear on our science education problems. In doing so these ideas will expand themselves and their meaning. Let us not evade our responsibilities and opportunities. If we do so, others less well qualified for the job will take over.

PALMER O. JOHNSON
University of Minnesota

DISCUSSION

We may assume—in fact, we are certain—that in the post-war period man will be very much the same as he is now, whatever be the changes in political forms and in economic organization. This means that methods of liberal education proved relatively effective yesterday will be equally effective tomorrow. Science education of yesterday could have been more effective in providing understanding both of man and of man's environment had we (the teachers) demanded more mastery and permitted less play; had we stressed understanding the method of science, the meaning of *controls and verified observations*, rather than memory. Some of this education the pupil must get by doing, by direct observation, or by experiments rather than from books or by words from the teacher.

I think we can agree that without some training in science and some understanding of the scientific method the citizens of tomorrow will be nearly as bewildered by their own life and by their environment as were our forebears a million years ago. I think we can also agree that since understanding of the scientific method (and this is certainly one element in our minimal educational "core") can be achieved by pursuing any branch of the natural sciences, we (the teachers) might confer and reach some agreement as to what field in the natural sciences has now become most imperative for the more intelligent and just and, therefore, the better life of man. If that field is man himself, his health, his food, we have a huge task before us, for up to the present we have not (in my experience) done our best here. Our teaching has been: Do this, and don't do that; and we have provided little understanding of the whys of either. We expose (I do not say we educate) our youths every year, from kindergarten to the freshman class in college, to reading, writing, and speaking English. May I ask: Is *health* not as important as *speech*? Can the matter of human health in our increasingly artificial, crowded, and complex society be left primarily to tradition, habits, and the doctors? My answer is: No. Every citizen is entitled to be exposed to that understanding, in any system of education worthy of modern man. The responsibility is on us (the teachers) to develop and apply this "minimal core" at every stage of education for the intelligent life. Such a program in education breaks with many cherished traditions. But as I see it, the growth of science and the application of science, the population problems, the speed of travel, and the possibilities of peace on earth render such reorientation, re-evaluation, and reform in education really urgent.

A. J. CARLSON
University of Chicago

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To answer the question raised, those who are engaged in science education will have to be pretty clear as to what kind of world they want. It is evident enough that the high development of science is no guarantee that men will use it for good ends. This choice of ends is a moral problem. The scientist's devotion to truth within the field of his special interest is a moral choice likewise, but not broad enough to meet his obligation as a man.

It is fairly certain that scientists believe in the relief of human suffering; likewise in the increased production of goods for human use. They have worked consistently toward both of these goals. Are they willing to work as hard and as consistently for peace and good will among nations, for justice and humanity within the nation? Without these greater conditions, science merely becomes a means of increased evil and destruction, of suffering and want.

Science education must be in the hands of men who have mastered science to the point where they know its limitations and are willing to make them clear to others. They must have attained a certain modesty about science. They must see their own field in its relation to other fields of science, and to the rest of human knowledge. They must understand that science is, after all, but one phase of human experience, no matter

how widely and deeply it may penetrate the unknown. Science education is neither a job for cheap, half-trained help, nor for men whose vision, however sharp and clear within their specialty, is blind to that which lies outside of it.

Since the high school is the capstone of the present common-school system, it is of particular importance in science education. At present it suffers from troubles whose origin is twofold—above it and below it. A sense of scientific reality ought to begin with our first training in language. The "scientific attitude" is not something that can be left to chance or late implanting. It must be nurtured from the beginning of education; there is plenty of experience to show that it can be.

On the other hand, those who teach in elementary and secondary schools are products of our colleges. Almost inevitably they will teach what they have been taught, and teach it from the same viewpoint. At the college level, in my observation, students too often are not given a balanced picture of the world in which we live, as science can interpret it. Each science department carries on more or less its own sector, disregarding the others. This is even true within departments, where, as William Crocker once put it, "the physical chemist looks down upon organic chemistry, and the organic chemist thinks that biochemistry is a mess."

I should say, too, that in many colleges those who teach the general courses in the various sciences are more deeply concerned with the 10 per cent of their students who will become specialists than with the 90 per cent for whom that general course should be made a golden opportunity. Not a few of this 90 per cent will become teachers.

The immediate point of attack, it seems to me, should be at the college level. I have no magic formula. But I do think that in every college, those who teach the elementary courses in science should get together with each other and with a few clear-headed critics from outside and talk and work the problem out until, in a sense that is not now true, they are able to speak a common language and carry on a common task.

PAUL B. SEARS
Oberlin College

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Needs for improving science education existed before the war began. The war has emphasized, enlarged, and otherwise changed those needs. Achievements in applied science, partly unannounced as yet, have made the whole world science conscious. Fundamental discoveries, also partly not yet announced, make certain that following the war there will be reorganization of what we think in some fields of science. These fundamental discoveries will also become the basis for new industries, new applied uses of the products of research, and differently trained workers. One of the good outcomes of the terrible conflict is the great growth in knowledge, even though that growth comes as part of the gigantic efforts focused on preserving ourselves and killing our erstwhile enemies. Another of the good outcomes is the rapidly spreading conviction that people generally must possess and use more of science and of its ways of working. Science education is no longer merely a privileged opportunity. It is an obligation in a democracy that is to endure.

The answers to the question of next steps are not obvious, but must come through intelligent experimentation in which are used the scholarship, procedures, attitudes, and measures of results that are worthy of science itself. Dr. Visscher recently said: "This question cannot be answered by evasion because it is on the public mind as well as our own. If we do not give a satisfactory answer the public or college administrators may give it for us in the form of a directive, perhaps less congenial to us and less useful to society than our own solution could be." *

A different point of view of science for general education is needed by some of those scientists who teach general courses. Sometimes the controlling idea seems still to be that an intensive and logical course in a special subject is best for the subject and for the student who will later study more science. Such a course, it is claimed, is good enough, possibly best for students who will not later study science. Neither claim is valid. The specialist-to-be and the general student both have enduring needs for foundations in significant science. The kinds of instruction which endure with lawyers, business men, home makers, and all educated citizens may also help to keep a highly specialized scientist in a position of understanding the world to which he belongs. Such general foundations might possibly help to keep a few specialists from mistaking their specialty as the prime necessity for general education. Such foundational understandings might also make it clear that the general and significant aspects of biological and physical sciences are more useful in general education than are the logical relationships and closely organized aspects of specialized courses in botany, zoology, physiology, chemistry, and physics.

We continue to hear complaints that not enough young folks are studying the sciences. Different statistical reports are confusing since they do not agree. It is implied or stated that more students should be required to study science. Certainly all should have a chance to study science. That point is not so important as it is that we shall recognize and provide for the new and widely distributed types of needs and interests in education in science which the activities and experiences of the war have produced. We talk about the age of science, about scientific discoveries and achievements, and about the scientific ways of working. Our courses of instruction, our text-

* Visscher, Maurice B. "Basic Biology and General Education," *Science*, May 12, 1944.

books and other reading materials, and our teacher training lag far behind the advancing understandings of the place of science in the world of today and tomorrow.

OTIS W. CALDWELL
Boyce Thompson Institute for Plant Research

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The attack on Pearl Harbor effected an immediate and profound change in the philosophy, and consequently in the major objectives, of science teaching. At the secondary-school level, and to a considerable extent at the college level also, the emphasis was shifted from science for cultural or propadeutic education to science for survival. Under the spur of immediate necessity old courses were redesigned and new courses were constructed. Their common major objective became vocational training rather than the development of broader understandings. The vocation for which these courses were specifically designed was making war. The training for this vocation, included in the "pre-induction" courses and units, embodied the teaching of specific skills and definite facts which the combat forces and their indispensable auxiliaries behind the front must learn.

When peace shall finally come, and earlier to the extent that the lessening of the imperative wartime demands may permit, the philosophy and the objectives of high-school and early college courses in science will probably be revised to resemble those of pre-war years, but with a somewhat different emphasis. Science education is obligated to direct and effect these changes. By so doing it will be making contributions of far-reaching consequence. In the secondary-school courses in science, and at least in the science-survey courses at the college level, it will be to strengthen beyond its pre-war force, the ideal of science for general education. In harmony with this ideal, and in contrast with the "pre-induction" work, it will direct the emphasis again upon the teaching of facts as a means to more important ends and not as an end in itself. One major objective of post-war science will be to stress the teaching of scientific principles, not only those that promise practical utility in everyday living but also those biological generalizations that provide a basis for an understanding of the ecological and sociological problems which must arise in a community that embraces all nations. A second objective will be to emphasize the development of scientific attitudes, especially those which will implement the attack on totalitarian ideals and the myth of "Nordic supremacy" abroad, and those which will combat the stultifying effects of intolerance, prejudice, insularity, and provincialism at home. A third objective will be to define and direct the training in the skills of problem solving, and thus, to the extent that transfer may be effective, it may be expected to equip and motivate an increasing number of individuals to apply the methods of the scientist to the solution of the multiform problems of a war-exhausted world.

The dislocation of the educational programs of so many thousands of men and women by their induction into military service has focused attention to an extent never before experienced, upon the need for making available opportunities for study through facilities other than those normally provided in the schools and colleges. In the postwar period accelerated programs in science as in other areas will of course need to be provided at the high-school and college levels for those veterans who will attend these institutions. For the enormously greater numbers who will not attend high school or college, however, a wide variety of courses in science needs to be devised and perfected for purposes of adult education. The definition of *adult* in this case includes not only those released from the armed forces, but also out-of-school boys and girls and adults of all ages, interests, backgrounds, and abilities. The list of such courses may well include many for general culture, others for the broadening and deepening of interests and knowledges, and still others for the development of hobbies. It should include also varied practical and vocational courses, constructed to serve specific needs of various localities.

Science education can make perhaps its greatest contribution by capitalizing, stimulating, and implementing the present widespread impetus toward the acquiring of self-improvement through more education in leisure hours, to the end that practical and pleasurable study may become, in all sections and for all ages, a universal avocation.

FRANCIS D. CURTIS
University of Michigan

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The testing of the nation's youth and a fair sampling of its young women by the armed forces and by war industries has provided a check on the accomplishments of America's enormous educational system. The check has revealed serious weaknesses and inadequacies.

Although specific results have not yet been tabulated or released to the public, it is well known that the tests have shown that our schools have had only slight success in the teaching of the basic skill subjects, notably arithmetic. In the fields of science, the tests have shown that students were exposed to far too little science instruction in view of the scientific, technical, mechanical nature of life today. Also much of what they did learn in science classes has not carried over into their everyday living; apparently the subject matter was not related to their personal experiences. This is also true of the health education to which they were subjected, for many of the habits of the average American youth have been found to be quite unhealthful.

In view of these findings it seems that leaders in science education have two tasks: (1) to work

for the allotment of a larger portion of the school program to science instruction and (2) to improve the results of science teaching by making it less academic and more closely related to current living.

(1) Science has not been a major subject in the public school curriculum; it has been a secondary subject in a program dominated by arithmetic, language, and social studies. Of course those subjects are important, but science education has fully as much to contribute to the preparation of America's youth for adulthood. In view of the extent to which science now enters everyone's life at work and at home, social studies alone cannot do the whole job of teaching young people about our world and how people live in it and how they themselves can live in it successfully. Science must be given the opportunity of helping much more than it has in the past; it must be given a major role in all of the grades of the public school curriculum. It is the job of the leaders in science education to convince the administrators who organize and run the schools of America of the truth of this idea.

(2) For years we have been telling public school teachers and administrators that to be successful, their science teaching must be related closely to their pupils' lives and to current everyday living rather than to be built around scientific laws and the laboratory. But apparently most science teachers went right on presenting diluted versions of college science courses; we were not successful missionaries. But we are going to have to be if we are to succeed permanently in our task of getting more time allotted to science education.

In general our whole educational program, including science, has been starting specialization too early. In recent years, as the school program became more elaborate, there has been a tendency to introduce trade education and professional training in the high school rather than to give pupils a broader and more thorough general education that would prepare them better for life or for learning a trade or a profession, if they desire, after leaving high school. Therefore our high school graduates have neither an adequate general education nor an adequate trade or preprofessional training. Post-high school training, at college, trade schools, and on the job, has been handicapped by the pupils' inadequate general education—their lack of general knowledge and their lack of skill in arithmetic, reading, spelling, writing, and so forth.

Life in America has become so complex and technical that for every citizen a much broader and more thorough general education is needed if he is to be a useful worker and a good citizen. Science plays a major role in American life today, and science can and should have a prominent place in our public school curriculum which is supposed to prepare the next generation to live successfully in this complex, technical society. Science must be a major part of American education, and it must be taught as a guide to successful living, not as an introduction to professional training. To attain these two changes is the task that faces the leaders in the field of science education.

Jack Hudspeth
Austin, Texas

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No person honest with himself can say didactically what conditions may be in any field of human endeavor in post-war times. There are too many variables, each subject to questionable interpretation, to make any prognostication much more than a guess. However, it does seem that a few conditions can be predicted reasonably accurately and these may foreshadow the situation they will produce. We propose considering here most superficially four factors that will be concerned with post-war school science: the faculty, the student, the times, and the program. Faculty and students in post-war times will be engaged in developing some sort of school science program. That seems well established.

The Faculty.—A colleague in the field of college education recently made the statement that he felt that students would come back from the war experience little affected by what they had been through. I believe he is likely to have to change his views on this subject and I believe he unfortunately represents a considerable proportion of our teacher-training faculties who will not have shared the benefits of travel, intensive training, rigid discipline, cooperative effort and practical experience that will be part and parcel of the background of a large proportion of the students who for awhile at least will sit in his and in similar classes. The faculty of the future must be composed of men and women who have the imagination if not the experience to understand something of the background of those who will predominate in our average student body.

The Student.—A generous proportion of our student body will have been making more or less definite plans on what they want to do "when the war is over." Because of this, they will be more purposeful in what they undertake and they will undoubtedly be more mature than those who might have spent a similar number of years in the classroom. I predict they will be more realistic, more insistent on results from their efforts than they would have been without a war background. I rather expect they will be more likely to assert the authority of their own judgment when generalizations and philosophers are developed by those without the background they have.

The Times.—It is anyone's guess as to what the times may be after the war. I pessimistically believe that we are likely to have a period in which individual initiative will be increasingly throttled and in which we as a nation may without our consent find ourselves committed to world projects that will exhaust our national resources to such a point that it may be difficult if not

impossible to carry on even for ourselves the public education programs on which most of us believe our present civilization rests. If the times are such that adequate programs cannot be carried out even though we do promise extensive training to returning soldiers at government expense then we will be forced to do more with less in the hope that we can make the most of what little we may have left.

The Program.—Among the features of any science program that may get greater recognition in post-war times, possibly the following are a few.

Since our enlisted men and women have been deprived of some years of formal training we will face a period of training in which residence requirements will be reduced and concise, realistic, functional programs will take the place of long-time required courses in which avoidable duplication and unnecessary busy-work have not been eliminated.

Since our student body to a considerable extent will have learned to live in the open and will have seen parts of the world they never knew existed, I predict that a generous proportion will have developed an appetite for a further understanding of the world, and that our school programs will have to recognize this situation. I believe that there will be a great interest in the problems of wildlife management, of conservation and outdoor living, as well as need for ability to operate the machines that are used in transportation and communication.

During the period of reconstruction, when there will be a great demand for labor and talent to reconvert our efforts to the activities of peace, there will probably be a need for programs in which students can work while they study, either by extension courses for those in service or by comparatively short intensive resident programs.

With the world-wide responsibilities that we will undoubtedly have there will be need for broader training for those who may wish to become our representatives in world affairs.

It does not seem possible that in the next decade at least we can return to the "normal" to which so many of us had adjusted ourselves. Much of the shoddy work that has passed as science in the elementary schools, secondary schools, and training schools will be found wanting in the intensive demands of the new times. If this is so, there will be at least some gain for the tremendous loss we all will have experienced through the folly of a war-geared civilization.

E. LAURENCE PALMER
Cornell University

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I assume that the principal difference between post-war education and pre-war education will be a difference in attitudes on the part of educators. The attitudes of science teachers and of educators in general may be very greatly changed. There will be a disposition to try new ideas. There will be a considerable turnover of teacher personnel, which will favor innovation and experiment.

In my judgment two principal and related changes are of the utmost importance and desirability. These two changes are: differentiation of the science curriculum into pre-professional science courses and courses for general education, and bold experimentation in science courses for general education.

The Need for Differentiation.—One thing which has been holding back experimentation in science as part of general education is the very proper concern of science teachers for the adequate preparation of a small fraction of their students for college work in the scientific fields, such as chemistry, physics, medicine, and engineering. Some teachers have felt that a course designed as preparation for college courses in the same field was a first necessity, for the sake of the few students who would make this use of their high school science. They have tended to ignore the large group of boys and girls who will not make a vocational use of science. Other teachers have argued that a good high school science course for the purpose of general education would be adequate for the prospective specialist in science. But neither group had an adequate solution for the problem.

The solution lies in making an explicit differentiation between science courses in physics, chemistry, zoology, and botany for the prospective specialist and science courses for the purpose of general education. The standards should be set high enough in the pre-professional courses to challenge the best students and to discourage the poorer students. The guidance program of the high school should be relied upon for aid in selecting the students who should be encouraged to take the pre-professional courses. The small school, which has too few students to permit science courses of the two types, should provide for differentiation within the course by giving the prospective specialist extra opportunity to do laboratory work and perhaps an extra class period a week in which the more technical material is considered.

The science courses for general education should be designed for students of both high and low ability, who do not intend to specialize in science. There should be three principal objectives: First, teach the modern scientific view of the nature of the world and of man. Second, teach for the promotion of personal and public health. Third, teach for the wise utilization of natural resources.

Much bold experimentation is called for along these lines. Probably the end result will be a one-year course in biological science and a one-year course in physical science, these two courses to be generally required of all high school students except those who take the pre-professional courses.

ROBERT J. HAVIGHURST
University of Chicago

If we are to have a satisfactory science program after the war we must analyze carefully the strong and weak features of the program we had before the war. We must correct or discard the weak features and expand and amplify the strong. It is generally agreed that our pupils in the past have been subjected to a type of natural science which was highly academic, overly theoretical and unrealistic. Our main purpose has been to prepare students for college when it was generally known that only a small per cent would enter college, and a still smaller per cent would take no more than a year of science in college.

The Army and Navy tests seem to indicate that the general fund of scientific knowledge acquired by high school pupils is entirely inadequate for modern war and industrial needs. This is largely due to the fact that 70 per cent of high school pupils take only two years of science or even less. Certainly we cannot expect pupils to acquire the necessary scientific knowledge in so short a time. However, the records substantiate the claim that our pupils have been so trained that they can acquire the needed knowledge much more rapidly than we had assumed they could.

I believe we are justified in saying that in the future we must plan a continuous program of science in the elementary and secondary schools. Pupils now are in continuous contact with language, mathematics, and some form of social study in the elementary schools. Why not have pupils enrolled in science courses on the same plan? If we can develop such a program then our pupils in the twelfth grade could easily be doing a level of work equal to that of the freshman year in college, possibly the second year in college. This does not necessarily mean the same subject matter, but a subject matter of equal difficulty.

The science offered in the new program must be functional; that is, it must become a vital part of the daily life and experience of our pupils. It must be so useful that pupils will recognize its value and realize its importance in what they do and how they think. The experiences we provide pupils in the classroom, then, must be more similar to the kind of science they see outside of school. They must have a science laboratory which will supply them with materials, machines, tools, appliances, inventions, and with apparatus which will demonstrate fundamental discoveries and processes. This is not a plea for more formal laboratory work, but for a laboratory program which will give pupils first hand experience with the tools, methods, and processes which scientists have created and which have done so much to raise our standard of living and bring about more comfortable ways of living.

In order to make such a science program possible I am suggesting the following plan. Pupils will be provided a continuous science program in grades 1 to 6, a general science program in grades 7 and 8, elementary biology in grade 9, and physical science in grade 10. All pupils will be expected to complete the program up to this point, although all of them may not do it in the allotted time.

In grades 11 and 12 a differentiated program will be provided, based on local needs and the size of the school. A thorough, intensive course in physics will be offered in the eleventh grade, with an equally intensive course in chemistry in the twelfth grade. The order of these courses may be reversed, depending on local circumstances. If a pupil completes the intensive course in physics, he will be well prepared to undertake the advanced study of mechanics, aviation (including meterology and navigation), and radio and electronics. Special courses may also be offered in optics and photography, heat engineering, and air conditioning. All these specialized courses would be taught at the level that would give pupils a thorough understanding and background for some vocational choice they might make. The courses would be more practical than vocational in nature. Advanced courses could also be provided in household chemistry, nutrition, health, sex education and heredity, as well as many others. These thorough, intensive courses will be just as good, if not better, college preparation than the present academic courses.

For those pupils not interested or qualified to take these advanced courses in grades 11 and 12 it will be necessary to provide a year's course in science that will be built around problems which are to some extent social in nature and which have their beginnings in scientific discoveries and inventions.

I believe we have postponed the intensive study of science too long. While we are very anxious to have pupils make extensive applications of principles learned, we must not forget that pupils cannot make these applications unless they thoroughly understand the principles. Applications without understanding are too often just the reciting of words. Many pupils will be ready for intensive study in the ninth grade if they have had a good science program in the first eight grades.

Intensive study does not necessarily mean the delimiting of knowledge to a very small area but rather the thorough understanding of a principle or generalization carried into as many fields as necessary to secure the understanding. Intensive study also involves the ability to use the tools the scientist has developed, to plan and design methods of securing information through the use of these tools, and to summarize and interpret data and evidence. It includes methods and purposes as well as content.

The fund of scientific knowledge has increased so rapidly that the only way we can expect boys and girls to keep up with it is to provide an expanded and more enriching type of program in our schools. The program suggested here will give boys and girls at the end of the tenth grade

a higher average fund of knowledge than was formerly given in twelve grades. The science to be provided in grades 11 and 12 is the real challenge. Whatever courses are designed must meet this challenge.

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I believe that three statements sum up the concepts which should be recognized and applied if science education is to make its greatest contribution to the post-war world.

First is the desirability of correlating science with other fields of knowledge as far as general education is under consideration. The principle of the unity of knowledge in the functional human being must be more widely accepted. Departmentalized education has its special functions in the field of research but its overemphasis on levels of general education is undesirable. Much has been accomplished in achieving emphasis upon science rather than undue emphasis upon physics, chemistry, zoology, and botany, for example, at lower levels of schooling. Too early specialization is to be deplored in general, although there may be individuals who are ready for it early in life. But I believe progress will be even more rapid if the nature of science and the methods of science are integrated into learning and teaching units involving social science, language and social intercommunication, and quantitative and qualitative thinking. This implies a definite effort to unify knowledge to function in the lives of individuals for richer and more complete living. Science educators must work for the elimination of departmental barriers and the integration of vital objectives of science education into all realms of formal education.

Secondly, there is need for the incorporation of the objectives of science education into the larger and more inclusive objectives of education of the whole personality. Unless science education has objectives in conformity with objectives of education as a whole, it will fail in affecting large groups of people. It will attract only a few rater than many students. Science education must show that it is really a necessary part of the good education of every person; that the neglect of its major objectives will prevent world understanding; that application of its methods and purposes will facilitate the just and correct solution of all problems of life. The problem of a mentally and physically healthy world population, for example, will only be solved by the use of systematic, scientific methods of attacking the problem. Similarly all vital world, community, and personal problems will yield only to unprejudiced, objective, reliable, and valid methods of solution.

Thirdly, the principles of science education must be in accord with the principles of general education. For example, the following is a principle selected from a long list: "Attitudes should stand high in a list of objectives, because they are so intimately associated with the determination of behavior—the final criterion of successful functioning." Science education should apply this principle as well as should art education; or education involving mathematics, or history, or the humanities, or the social studies. Science education is only a part of the education of the whole man, and a very essential part, I believe. Growth and development of the individual from a bundle of potentialities into a functioning personality who adds his quota to the progress of society as a whole is the more inclusive purpose of education generally and of science education as a worthy part of all education.

All these statements sum up to a need for a reorganization of the whole curriculum which puts an end to present disunity and artificial division among the courses composing the curricula in our schools. We are ready for a new and functional type of curriculum acceptable to all truly educated individuals, in which there will not be competition and strife for student attention and financial appropriation. The challenging problems of contemporary life may well serve as centers of curriculum, course, and unit organization; and science, history, mathematics, sociology, economics, and all other vital aspects of life will receive their due share of attention. The eventual outcome will be a better attack on these vital problems.

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BOOK REVIEWS

LILIENTHAL, D. E. *T.V.A.—Democracy on the March.* New York: Harper and Brothers, 1944. 248 p. $2.50.

Mr. Lilienthal has given the first popular account of the activities and accomplishments of the T.V.A.—one of the great social experiments of all time. His report is a comprehensive, thoroughly readable, and even thrilling summary of the progress made during the first ten years of the T.V.A.

Those who are interested in the use of developments in science and technology for human welfare will be greatly challenged by the underlying purpose of the T.V.A. It is not enough to do the job of reconstruction and rehabilitation, build the dams and construct the power lines, restore the soil and increase production. The job itself is less important than *how* the job is done. "The spirit in which the task is undertaken; its purpose, whether for the welfare of the many or the few; the methods chosen—these will determine whether men will live in freedom and peace, whether their resources will be speedily exhausted. . . . The physical achievements that science and technology now make possible *may bring no benefits*, may indeed bring evil, unless they have a moral purpose, unless they are conceived and carried out for the benefit of the people themselves." Mr. Lilienthal believes that if such a purpose is to be achieved, two principles are essential. The first of these is the principle of the "unity of nature," which must govern resource development. The second principle states that the people must participate actively in whatever resource development is undertaken. It hardly need be pointed out that both these principles have been consistently violated in the development of our natural resources.

The principle of the unity of nature is well known to science teachers. They have long recognized the importance of the interdependencies and interrelationships that exist among living things, including man, and between living things and their physical environment. But to apply the principle in those situations where man takes an active part is difficult. The building of a dam for utilizing the energy of falling water is the development of an important and permanent energy resource. Yet to do this without proper consideration of the land drained by the river and the living things dependent on the land may ultimately destroy in part the usefulness of the land itself.

Dam building in the Tennessee Valley is always part of a larger scheme. The dam structure itself with all its appurtenances is the most obvious symbol of development. But we must not mistake the symbol for the substance. Behind the dam lies the land, the life rooted in the land, and the rain falling on the land. Through countless rivulets and subsurface channels the water flows until it finally reaches the lake formed behind the dam. It flows onward through giant steel tubes and turns a water wheel as it falls. The water wheel moves the great generators which translate mechanical energy into electrical energy. This electrical energy goes over high tension wires to the phosphate furnaces where the inert phosphate rock is changed into a chemical fertilizer of great value. Back to the land comes the phosphate to induce new life. This new life provides energy for man and animals, holds the soil in place, frees the streams of silt, stores up the water in the soil. Slowly the now clearer water returns again to the man-made reservoir, more energy is generated as more and more water from the restored land flows on its cyclic course. Here indeed is an endless cycle from which all-important energy can be extracted—energy for improving man's life, for running his machines, for lighting and heating his home, for refining needed metals. As by-products there are improved navigation and new recreational possibilities. How permanent is all this? Everlastingly permanent, as long as the principle of unity is obeyed. "The yield is not the old sad tale of spoilation and poverty, but that of nature and science and man in the bounty of harmony."

The second principle, participation by the people in resource development, is "democracy at the grass roots." Since its inception, the T.V.A. has considered people as the most important facts in resource development. "A world of science and great machines is still a world of men; our modern task is more difficult, but the opportunity for democratic methods is greater even than in the days of the axe and the hand loom." The creation of a renewed sense of individual worth would be justification enough for the use of "grass roots" methods. But there is a practical reason for encouraging people to participate in the task of building a region's resources. *There is no other way in which the job can be done.*

Much of Mr. Lilienthal's account is devoted to the story of how purpose and principles have been implemented in the Tennessee Valley. In the reviewer's opinion, this story is the most significant and far-reaching part of the account. Two other important points, however, should be mentioned.

Most of us are aware of the dangers inherent in over-centralization and the resulting excessive bureaucracy that follows in its train. Yet we also recognize the inevitability and the benefits to be derived from a measure of centralization in our political and economic life. Mr. Lilienthal believes that the key to this problem lies in divorcing the idea of authority from the idea of the administration of authority, in employing "decentralized administration of centralized au-

thority." His discussion of this point with reference to the Valley is very illuminating.

Beyond our immediate horizon lie many river valleys with resources underdeveloped or developed in harmful ways. Does the Tennessee Valley experiment have any significance for these valleys? The author thinks that it does and in a very interesting chapter develops his point. His key conclusion is that "in any perspective of time, unified resource development anywhere helps everyone everywhere."

The book is tremendously significant. It is of great importance to science teachers because it is the story of the wholesale application of science and technology to the problems of a large river valley. The modern "Aladdin's lamp" has been put to work in the interests of all the people and in such a way as to move them nearer to full and understanding participation in the shaping of their lives and their culture.

—Hubert M. Evans.

NATIONAL RESOURCES PLANNING BOARD. *Regional Planning—Part XII. Arkansas Valley.* Washington: U. S. Government Printing Office, June, 1943. 50¢.

This plan involves parts of seven states, Arkansas, Kansas, Louisiana, Missouri, New Mexico, Oklahoma, and Texas. It includes three major river systems, the Red, White, and Arkansas. About 7,400,000 people live in the region.

The income of the people of the region is $235 less per person than the average for the nation. In sharp contrast with the low income of the people and the meager development of the region is the fact that this is an area of great natural wealth. Few areas anywhere in the world have been so richly endowed by nature with the resources and materials necessary to provide a high standard of living.

In preparation of the general plan for the region the following features, having special significance for science educators, were examined and are reported in some detail:

1. Agriculture. Even with top prices farmers would still have inadequate income because production per man is too low, a condition due to poor soil and poor knowledge of high productive methods. The usual problems involving good land use exist in the region.

2. Industry. There is little development but great possibilities. Fuel is plentiful as well as such other raw materials as helium, limestone, glass sands, and ores of aluminum, lead, zinc, and iron.

3. Power. The region has a great abundance of gas, oil, and coal for fuel, the coal being only slightly developed. Natural gas is the energy source for 76 per cent of the electrical power. Potential hydroelectric projects can produce eight or nine times the amount now being produced. However, because of the rich fuel resources, even highly developed hydroelectric power will probably not produce more than 25 or 30 per cent of the electrical energy required. The plentiful supply of fuel resources presents an interesting variation of Arkansas Valley conditions as compared with the Tennessee Valley.

4. Water supply. There are many control and utilization problems. Flood control is a major problem, the solution being closely combined with water power development. High mineral content, particularly sodium chloride and calcium sulfate, reduces possible uses of some streams. Disposal of oil field brines is a major problem, with reinjection showing considerable promise as a solution.

5. Health. There exists much room for improvement. Malaria, hookworm, malnutrition, and typhoid exist in alarming amounts.

6. Education. There are in the Valley 780,000 young people between the ages of fifteen and twenty; 641,000 of these are not in school. Full use of educational possibilities necessitates new concepts of work training, housing, tools and equipment, and medical care. The report indicates that there is much need for integrated effort to acquaint the young people of the Valley with potentialities and problems of their environment so that they may throw their weight behind a program for community development.

Anyone interested in the education of young people, no matter where the locality, is urged to examine this Arkansas Valley plan. For such persons it has high potential value.

—George L. Bush.

STOUT, WILLIAM B., AND RECK, FRANKLIN M. *Tomorrow We Fly.* New York: Thomas Y. Crowell Company, 1943. 160 p. $2.00.

Predicting the future in aviation is a risky pastime for average persons, but these authors are well qualified to foretell what is to come in the field of aviation. Years ago Mr. Stout designed the Ford trimotor plane, which was as far beyond its time then as his current designs are now. His Skycar, which will fly through the air or run on the highway, is one of his later developments.

The authors answer such questions as: How much will private planes cost? Will aircraft freighters compete with railroads? Can everyone learn to fly the new planes? Can we go to Europe in six hours? Facts and figures on tomorrow's transport are given.

—Roy V. Maneval.

HEWSON, E. WENDELL, AND LONGLEY, RICHARD W. *Meteorology, Theoretical and Applied.* New York: John Wiley and Sons, Inc., 1944. 468 p. $4.75.

This textbook is intended for use in the beginners course in meterology now offered military students in many American colleges. It attempts to strike a happy medium in subject-matter difficulty between books that are too easy on the one hand and those that are too difficult on the other.

—C.M.P.